THE ENGINEER

AUGUST 8, 1952

Engineering Training Mission to Latin-America

AT the end of April, a British engineering training mission to Latin-America, sponsored by the Board of Trade and the Federation of British Industries, left England to visit Colombia, Venezuela, Cuba, Mexico, Peru, Chile, Argentina, Uruguay and Brazil. The members of the mission were Sir Arthur Fleming, Mr. F. R. Livock and Mr. W. V. Jenkins. The main purpose of the mission was, first, to investigate the technical training arrangements for young engineering graduates in these countries with a view to providing a selected number of them with scholarships for practical training in Britain and, secondly, to make known to all concerned, including government departments, industrialists and universities, the exceptional practical training facilities which Britain can offer. The mission has now returned from its tour and a full report of its findings will be published in the near future. Meanwhile, it may be said that the scholarships to be offered to Latin-American countries are an extension of the general overseas scholarships scheme of the Federation of British Industries, which was established two years ago as part of a long-term export trade policy as well as to assist overseas countries in process of economic development. Upon his return, Sir Arthur Fleming said that he and his colleagues were greatly impressed by the potentialities of the young Latin-American republics and their importance from the point of view of future British export trade. Their economic progress depended very largely on the work of the engineer to provide facilities for transport, communication, power supply and for the general development of their natural resources. There was, in fact, in those countries, a great need for fully trained engineers. The offer of practical training in Britain for their young engineers, Sir Arthur added, was received with the greatest interest and enthusiasm and there was no doubt that such young engineers trained in Britain would be this country's best trade ambassadors in these countries in the future.

Applications to Operate Scheduled Air Services

THE Air Transport Advisory Council has given notice that the Minister of Civil Aviation has now issued to it Terms of Reference and that it is, therefore, ready to receive applications from the Airways Corporations and British air transport companies to operate scheduled services and inclusive tours. The Council will consider all applications in accordance with the Terms of Reference and will make recommendations to the Minister, whose decisions will be final. Schedule "A" to terms of reference specifies routes on which, under the Government's policy, the Corporations will have reserved to them the right to operate normal scheduled services. In Schedule "B" are specified the routes on which the Corporations will have the right to operate "all-freight" services. The Minister will be prepared to consider under these arrangements proposals for the operation of services by independent companies on any internal route which would not materially divert traffic from either British European Airways or from independent companies already authorised to operate. Other proposals will be considered dealing with the operation by independent companies, to places outside the British Isles, of normal scheduled services and the operation by a Corporation to places outside the British Isles on any new route for which no independent company has been authorised. The operation of a "Colonial Coach" class passenger service by an independent company or by one of the Corporations along any route will also be considered, provided that such service is a lower class of service than that of normal scheduled services, as regards type of aircraft, shorter stage lengths, passenger amenities, baggage allowance, &c., and operated to a stated frequency closely related to the requirements of the new class of traffic at a fare not exceeding a fixed sum, low enough to ensure dependence on the new class of traffic. The operation of vehicle ferry services which may also provide for passengers so limited in number as to avoid material diversion of passenger traffic from other authorised services, and the operation on any route of a helicopter service, irrespective of the existence of a fixed wing aircraft service, will likewise be considered.

International Classification for Coal

THE United Nations Economic Commission for Europe has stated that a working party has now reached agreement on a practical system for describing European coal by its essential characteristics. The development of such an international system of coal classification was called for by Governments participating in the work of the Commission in order to provide a scientific basis to meet the needs of producers, traders and users for a common language when discussing coal. The Commission says that the classification system—which will now be submitted to Governments for approval and trial application—provides a relatively simple procedure for the accurate identification of fuels by qualities. It is felt that it should facilitate international trade in coal as well as encourage its efficient utilisation. The working party realised, of course, that most coal producing countries have systems for classifying their own coals; its problem was to create an international classification system into which could be fitted every quality of coal found in the various European countries and in North America. During the working party's study several hundreds of coal samples were exchanged among the co-operating countries for tests in their laboratories. Various testing methods were used and progress was steadily made towards eliminating differences between the sets of test results. To achieve as high a degree of precision as possible, laboratory staff met and agreed on methods, and for the final experiments a pilot laboratory was established in Rotterdam. The Commission's working party, it is stated, is now proceeding with studies on the international classification of brown coals and lignites. Proposals have already been considered for a definition to ensure a clear division between those fuels and hard coal.

South-West British Navigator Chain

SINCE the war, the Decca Navigator Company, Ltd., has developed its Navigator system, and at intervals a series of chains have come into operation. On July 29th, the fifth of these chains was officially opened by Sir Norman Guttery, K.B.E., C.B., the deputy permanent secretary to the Ministry of Transport and Civil Aviation. In the course of his speech, Sir Norman said that the Ministry had followed closely the development of the system and had conducted approval trials of each of the chains. Referring to the International Safety Convention he said that the Government had followed the recommendation of the London conference that encouragement should be given to developments in the field of radar and radio-position-fixing. Reference was made to the work of the scientists in the Government service and to the Admiralty Hydrographic Department for the production of the lattice charts for the mariner's use. At the present stage, 1100 British ships and 500 foreign ships were fitted with the Decca Navigator, including the "Queen Elizabeth" at one end of the scale, and fishing fleets at the other. Radar and the Decca Navigator were, Sir Norman said, complementary aids to navigation. The latter was proving its value in solving special problems, and was used for fixing the position of light vessels, the laying of cables, surveying, speed trials of ships, and in the oil pollution problem to plot drift. Sir Norman added that the South-West British Chain completed the coverage of United Kingdom waters, and that the coverage was extended across the North Sea and into the Southern Baltic by the Danish and German chains. The new chain was sited to give maximum help to deep-sea shipping coming from the Atlantic to English Channel ports, or bound for the North-West Coast through St. George's Channel.

Trinidad Refinery

ON Wednesday of last week, His Excellency, the Acting Governor of Trinidad, the Honourable P. N. Renison, performed the opening ceremony, at the Pointe-a-Pierre Refinery, Trinidad British West Indies, which brought the new catalytic cracking plant on stream. The construction of the new plant is part of the expansion scheme of Trinidad Leaseholds, Ltd., to enable its marketing organisation in the United Kingdom, the Regent Oil Company, Ltd., to be in a position to provide the highest quality petrol when premium quality branded petrols return. The increasing demand for the company's products has made it necessary to extend the refining resources at Trinidad and during the last six years the refinery, which now has a throughput of 75,000 barrels per day, has been extensively modernised at a cost of about £5 million, so that the plant at Pointe-a-Pierre is up to date and equipped with modern machinery. The Universal Oil Products Company of Chicago, U.S.A., was responsible for the progress design and the detailed engineering and construction were carried out by Foster-Wheeler, Ltd.

The Coal Utilisation Council

THIS week, the Coal Utilisation Council has issued its annual report which surveys the work accomplished during the year 1951. The object of the Council, it may be recalled, is the co-ordination and development of effort to secure the efficient domestic use of solid fuel in modern appliances. The report says that the sharp rise in public demand for improved solid fuel appliances encourages the Council to believe that more and more people are coming to realise that they owe it to themselves and the nation to burn solid fuel in modern appliances. During this year, it is the Council's intention to encourage higher standards of insulation in both new and existing houses and to seek the application of incentives to owners and occupiers of existing houses to install modern solid fuel appliances. The increasing demand, throughout last year, for instruction in the use of solid fuel appliances at the Council's training centre in Vauxhall, London, led to a decision to seek larger premises for the centre. During the year, fifty-one courses were held, and were attended by 1266 students. In addition to those held specially for appliance distributors' and coal merchants' staffs, courses were arranged for the National Coal Board's divisional chief scientists, young architects and clerks of works, and for War Office instructors in cooking by solid fuel. One of the Council's chief tasks, of course, is to provide impartial advice about modern solid fuel appliances to local authorities, architects, builders and others professionally interested in domestic space and water heating.

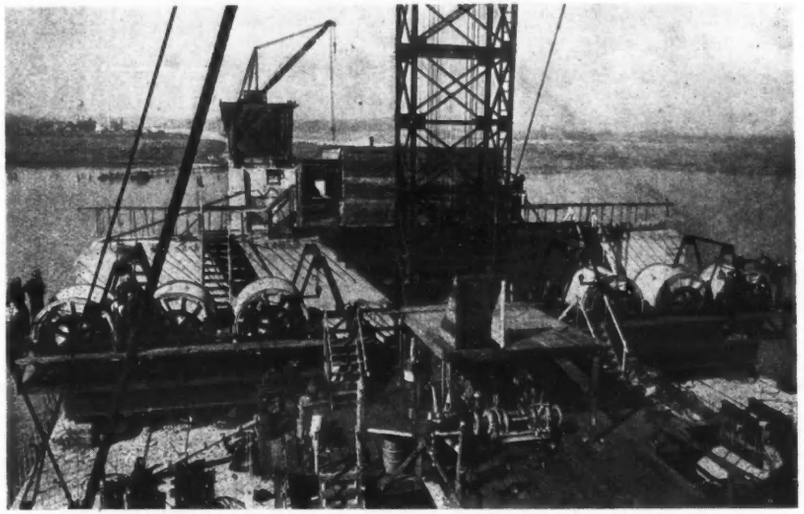


Fig. 12—Cable Spinning Machinery on Top of Anchorage

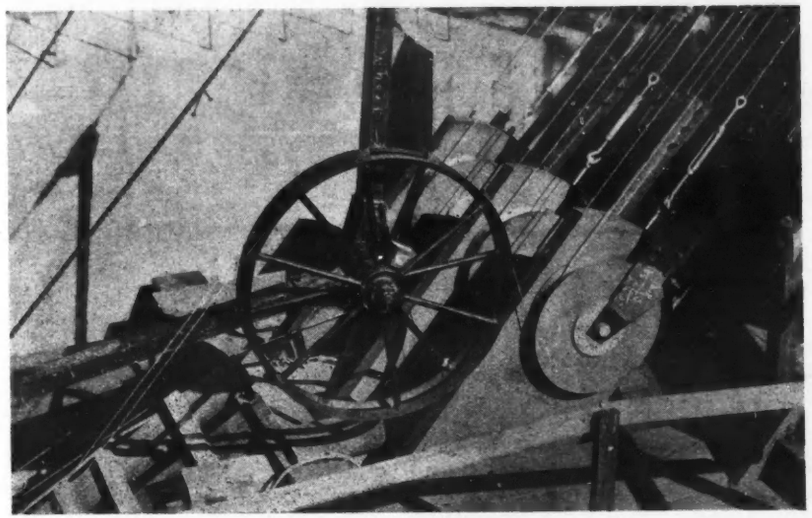


Fig. 13—Spinning Wheel commencing a Traverse

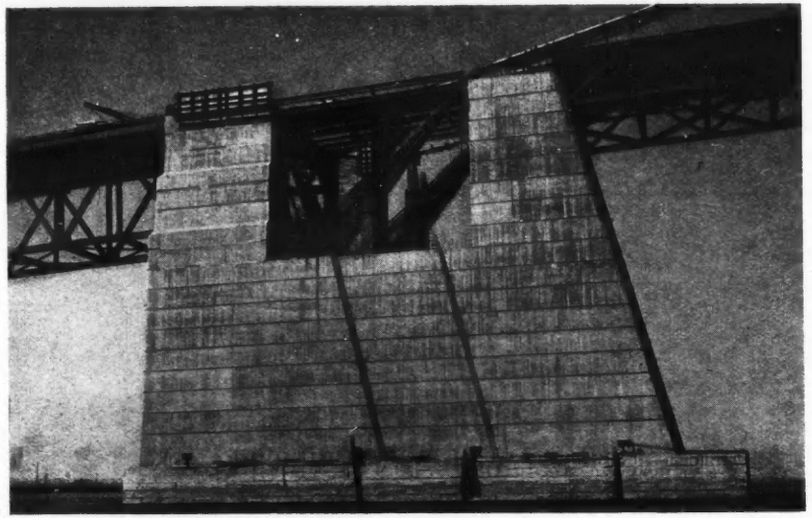


Fig. 14—Anchorage end of completed suspended Span

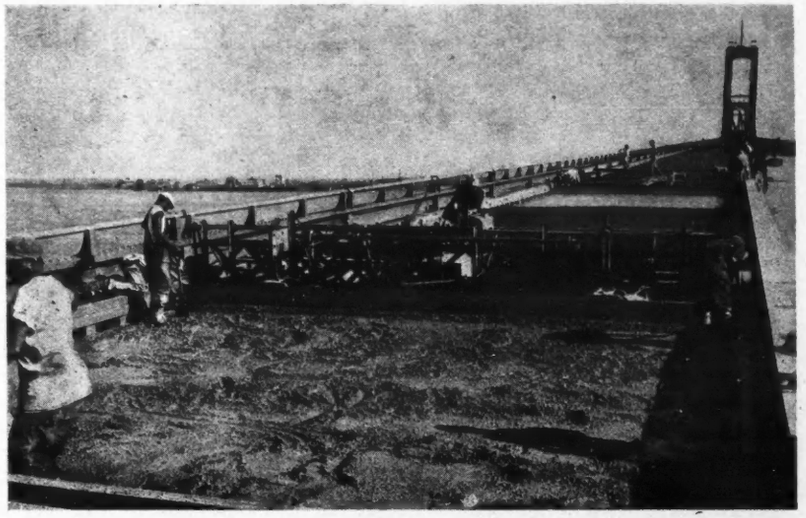


Fig. 15—Concreting of Bridge Deck

Delaware Memorial Bridge, U.S.A.

No. II—(*Concluded from page 150, August 1st*)

This road bridge stretches across the Delaware River close to its mouth. It is the sixth largest suspension bridge in the world with a central span of 2150ft, side spans of 1500ft, five truss spans totalling 1698ft, and twenty approach girder spans on one shore and three truss spans, totalling 1019ft, and fifteen other approach spans on the other shore. Its erection is here described.

The Superstructure

THE American Bridge Company, of New York, a subsidiary of the United States Steel Corporation, held all contracts involving steelwork for the bridge superstructure, including 15,700 tons of steel for the two towers and the suspended steelwork, 3400 tons of material for cables and suspenders, and 13,700 tons of approach superstructure steelwork. The company began steelwork erection upon the completion of the land approach piers at the end of February, 1950. From the west abutment east across the river, the superstructure consists of twenty girder spans, followed by five truss spans, leading to the west anchorage. Proceeding towards the New Jersey shore, there is a side span to the west tower, the central suspension span to the east tower and another side span to the east anchorage.. Again, there are five truss spans, which are followed by thirteen girder spans, leading to the east abutment. This combination of girder, truss and suspension spans carries two 24ft concrete roadways, separated by a 3ft raised "median," and flanked on each side by a 3ft 3in walkway. The floor system was designed for an H20–16–44 loading in accordance with the current specifications of the American Association of State Highway Officials. The live load on the stiffening trusses and towers was taken at 2250 lb per linear foot of bridge, and the wind load on the trusses at 30 lb per square foot, and on the towers and cables at 35 lb per square foot. The cables were designed on a basis of 5750 lb and 1125 lb per foot of cable for dead and live loads respectively, and for wind loads at 35 lb per square foot. The normal temperature for design purposes was considered to be 68 deg. Fah.

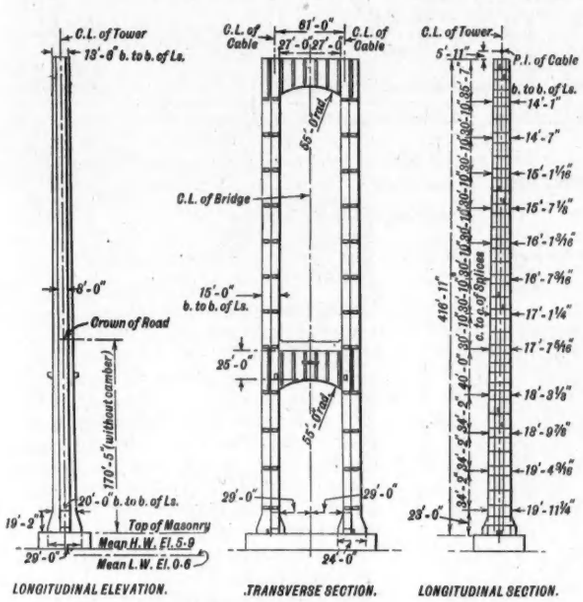


Fig. 16—Design of Towers

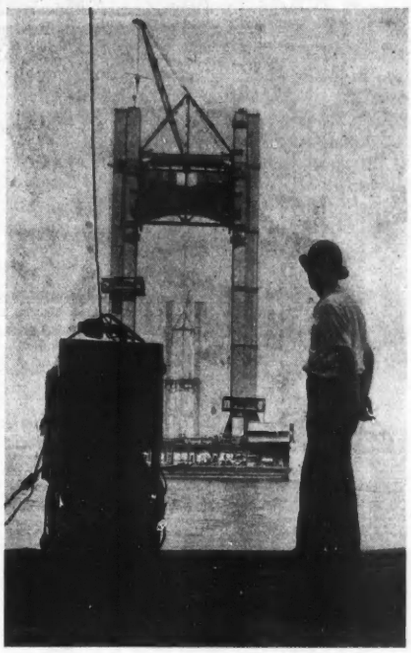


Fig. 19—Erection of Towers

Steel components for the girder spans and for the land truss spans were delivered to the bridge site by rail over special sidings running down to the water and parallel to the bridge. Material for the river work—towers, trusses, cable wires and suspension steel—was delivered by rail to the Wilmington Marine Terminal on the Delaware River, 3 miles above the bridge site. There it was

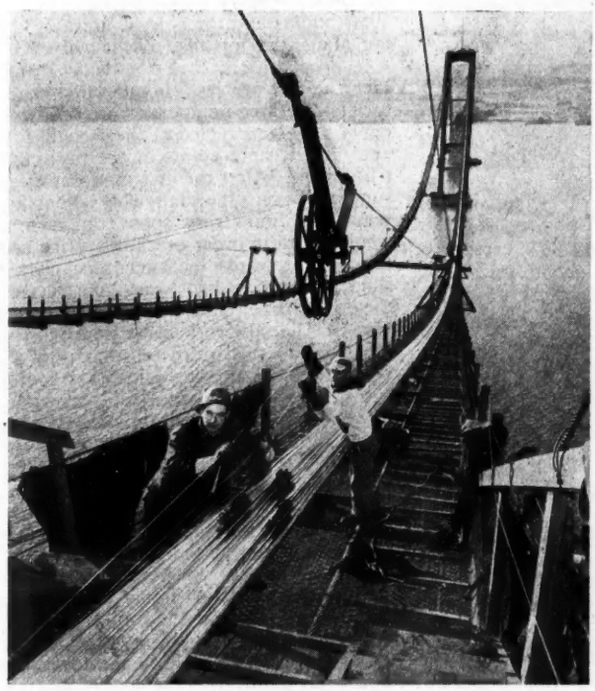


Fig. 17—Spinning Wheel Traversing the Centre Span

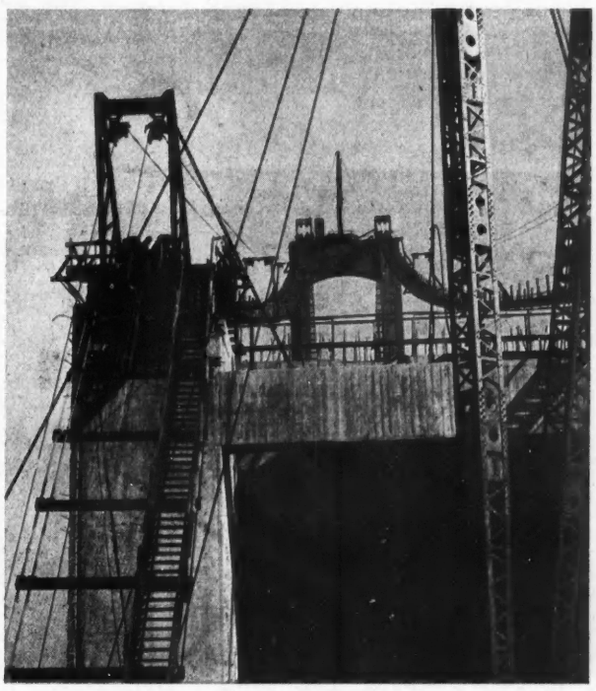


Fig. 18—Catwalks from Anchorage to Tower

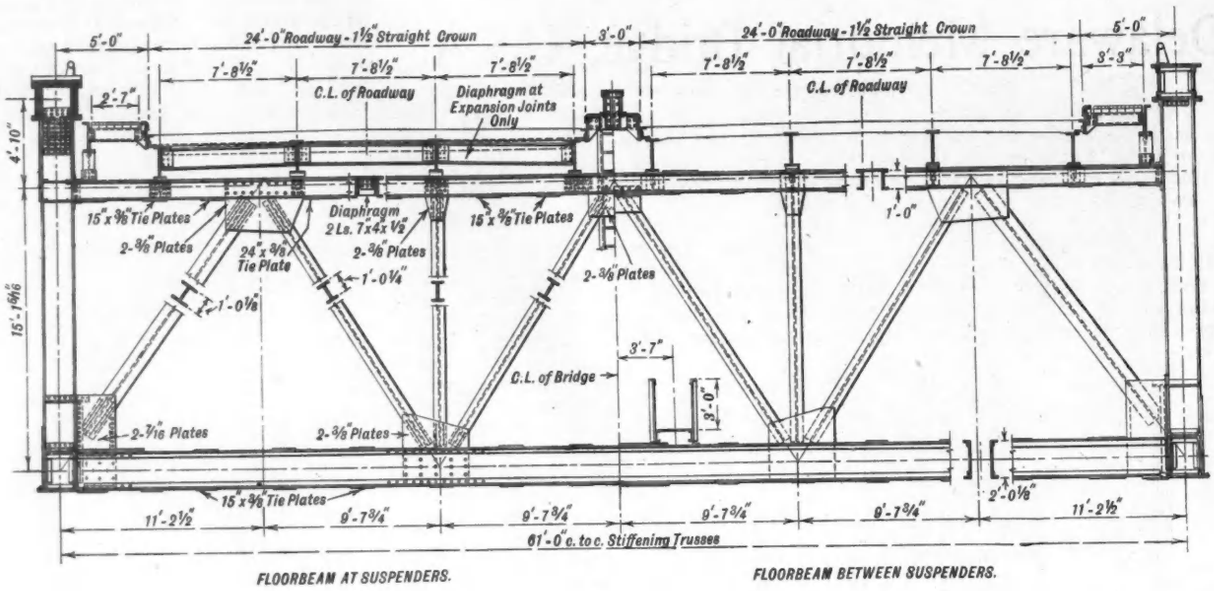


Fig. 20—Cross Section of Suspended Span

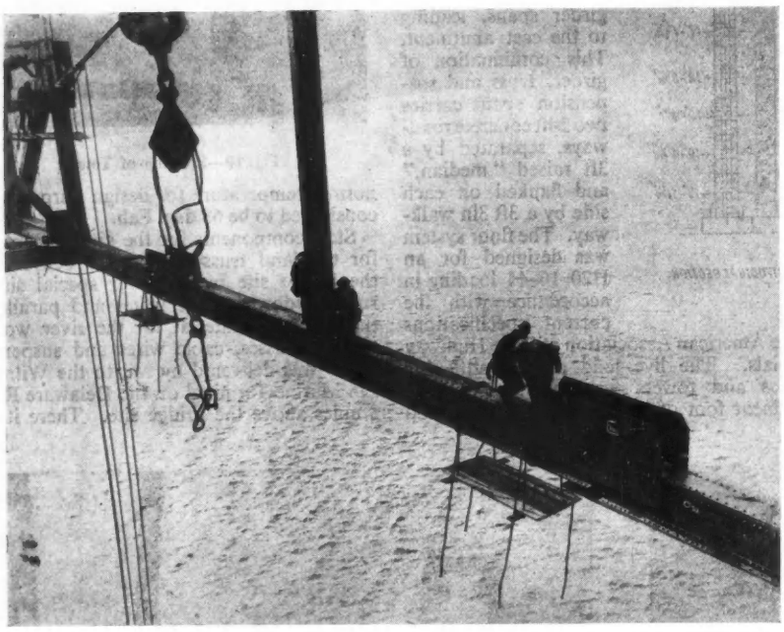


Fig. 21—Erecting Closing Panel of Stiffening Truss

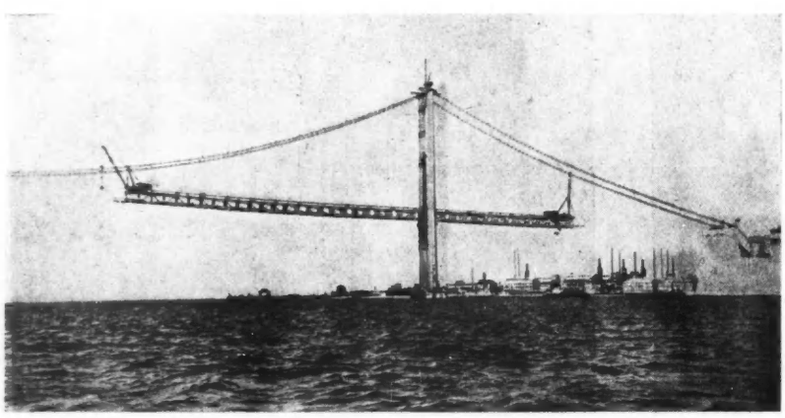


Fig. 22—Travelling Derrick Cranes Erecting Suspended Span

loaded on barges and towed downstream, where it was moored in position for subsequent handling. The girder spans, all over land, were erected by crawler cranes, two being allocated to each side of the river. All four units were equipped with 100ft booms and 30ft jibs. They unloaded and set the steel, which was first bolted and pinned and then riveted together. The longest plate girders handled by the crawler cranes were 116ft 8in long and weighed 35 tons. Four riveting gangs worked on each side of the river, driving the rivets from platforms hung on the steel members.

As the final plate girder land spans were erected, the crawler cranes helped to set up the travelling derrick cranes, one on each side of the river, which, subsequently, moved themselves forward over the floor system of the superstructure as erection of the river spans proceeded. The derrick cranes were of 55-ton capacity and were equipped with 105ft booms and three-drum hoists. Working along the top chords they erected the 40ft deep trusses over the water, placing them at 39ft centres. For the first span on each side, three temporary steel falsework bents were constructed at the second, fourth and eighth panel points of the twelve-panel truss spans. After the first span was erected, supported on the falsework bents, the remaining four truss spans on each side were erected in order by cantilevering across the water towards the anchorage piers. A single falsework bent was constructed at the eighth panel point of each of these other spans. The falsework bents were built with "H"-beam piles driven into the river bottom from a floating pile-driver equipped with a McKiernan-Terry double-acting hammer. The piles supported a steel grillage on which the bents were erected.

The two towers rise to a height of 416ft 11in above the masonry piers, on which they are built (Fig. 16). Each of the two shafts in the towers is 15ft by 20ft at the bottom and 15ft by 13ft 6in at the top, measured back to back of angles. Between the shafts there is a 58ft horizontal clearance at the bottom, decreasing to 54ft at the top. Most of the angle members are 8in by ¾in sections; the heaviest single piece in the tower structure weighs 50 tons. The tower design provides for thirteen vertical tiers, varying in length from 23ft to 40ft, the former at the

base and the latter at the roadway level. At the top the shafts are connected by an arched portal strut with a minimum depth of 25ft. A similar lateral connection is at the fifth tier from the bottom, just below the roadway. At the towers the crown of the pavement is 170ft 5in above the top of the masonry piers.

After the first two tiers had been set by floating derrick cranes to a height of 77ft above the water, a "creeping" derrick (Fig. 19) was set up on each tower to erect the remainder of the steel. The latter cranes had a capacity of 55 tons and were equipped with 90ft booms and three-drum hoists. Once the creeping derrick had erected steel

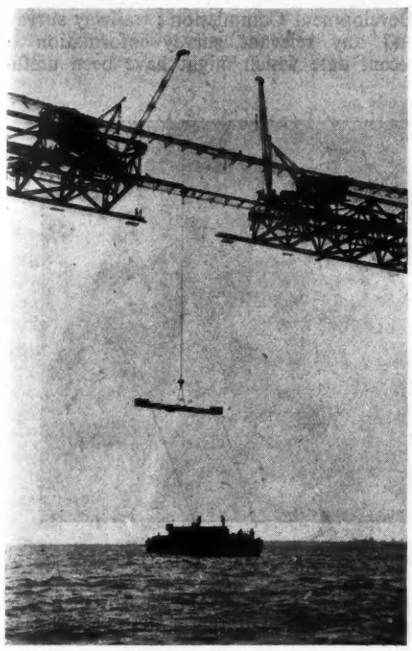


Fig. 23—Closing Centre Span

for two tiers it was "jumped" to a higher level with the aid of two sets of wire rope falls, one at each tower shaft. The maximum single jump encountered was almost 70ft. Ten riveting gangs were used in the tower erection, working on specially designed steel scaffolds, which encircled the periphery of each shaft leg and which were raised or lowered by means of winches. Instead of being tossed, the rivets were passed pneumatically through a flexible metal tube, which had a bore slightly larger than a rivet head.

After completion of the towers, conventional cable-spinning machinery was erected, the bulk of the equipment, including the spinning engines, being set up on the anchorages (Fig. 12). To spin the two suspension cables one end of the 0·195in diameter galvanised wire on the reels, which are held in cradles on the anchorages, is secured to a point at the spinning base. The loop thus formed is placed around the grooved pulley or "spinning wheel," which is attached to a power-driven endless traction rope extending across the river (Figs. 13 and 17). As the spinning wheel travels along the course of the traction rope, the reels are placed in motion and four wires, or two loops, are pulled from one anchorage to the other. A companion spinning wheel travels in the opposite direction, spinning two other loops in a similar manner. Thus, four loops of wire are spun with each trip of the wheels. A floating sheave tower at the anchorage is used to maintain proper tension as the wires are carried across the water by the wheels. The two cables of the Delaware Memorial Bridge hang at 61ft centres. Each cable contains nineteen strands, each strand being made up of 436 wires. The strands were anchored individually, (Fig. 14) compacted and, finally, wire-wrapped. The completed cable has a diameter of 20¼in.

Suspenders hung from the cables support the stiffening trusses of the suspended spans. The trusses (Figs. 20. 21, 22, and 23), like the cables, are at 61ft centres and are 20ft deep. They were erected by four 55-ton travelling derrick cranes, working from the towers. Two of the travelling derricks advanced from the tower piers until they met at the centre of the 2150ft span. The other two travelling cranes proceeded in the opposite directions from the towers, erecting the trusses over the 750ft side spans, until the anchorages were reached.

Upon completion of the steel superstructure, the bridge was paved with 7in concrete slab, reinforced at the top and bottom with a steel mat (Fig. 15).

The Delaware Memorial Bridge was designed by Messrs. Howard, Needles, Tammen and Bergendoff, of New York, and this firm of consulting engineers also supervised its construction on behalf of the Delaware State Highway Department. Mr. O. H. Ammann and Messrs. Moran, Proctor, Freeman and Mueser, respectively, acted as special consultants on the suspension structure and the bridge foundations. Mr. A. Gordon Lorimer was the consulting architect. The bridge was constructed at a cost of 44,000,000 dollars.

Applications of Scale Models in Engineering

By ROLT HAMMOND, A.C.G.I., A.M.I.C.E.

No. I

Amongst models discussed are one for the study of irrigation in Iraq, that of Malmo harbour used by Professor Hellstrom, a tidal model of the Thames Estuary for the study of siltation, that of the Mersey Estuary used by Professor Gibson, river models used by Sir Claude Inglis at the Poona Research Station, and models of a dog-legged staircase at the Festival Hall for the determination of stresses, and the Dome of Discovery for the study of wind loading.

THE use of scale models in many different fields of engineering is now a well-established technique, a comparatively recent development being the preparation of scale models from an air survey for the purpose of showing a complete engineering scheme, which it may be proposed to build, in relation to its surroundings. This kind of model is particularly valuable in those cases where it may be necessary to explain a scheme to a non-technical audience, or to obtain sanction for a project during its early stages.

Much of this kind of work is carried out by Hunting Aerosurveys, Ltd., who claim that by employing air photographs in combination with the latest photogrammetric methods, to which the author has previously referred in these columns, it is possible to attain an accuracy not obtainable by any other method. Such models are used for studying the routes of roads, railways or pipe-lines, for seeing at a glance a proposed drainage project or the layout of a proposed building site; in connection with national or local development schemes; to explain the layout of exhibitions and to provide the background effects for instructional purposes. The three-dimensional properties of the scale model supply a wealth of information in a manner which can be easily understood. Thus, the gentle slopes of farming country, the sharp features of a quarrying district or the sprawling untidiness of an industrial region can be made strictly to scale and can be realistically coloured. Likewise, the effect of some proposed scheme can be seen in true relationship to its surroundings, a very important consideration to-day, when all schemes have to conform to planning regulations framed to take into account the amenities and historical associations of the district.

The above concern made a scale model of Seaham to a scale of 1 in 500. Basic control for the model was taken from Ordnance Survey plans to a scale of 1 in 10,560 and the details of buildings, walls, hedges and woods were obtained from stereoscopic pairs of air photographs. This model faithfully and accurately displayed the new development which had taken place since the last Ordnance Survey plan was published. An accurate scale model was also made of an area in South-East Persia to a scale of 1 in 10,560, prepared entirely from air photographs, the basic control in this case being drawn by means of a Wild A.5

A—Shatt el Arab at Basra (combined rivers).
B—Karun River (Persia).
C—Hammar Lake (Euphrates enters and leaves).
D—River Tigris and Garraf at Kut.
E—River Euphrates.
F—River Tigris at Samarra (proposed barrage).
G—Wadi Tharthar (proposed flood-relief canal from *F*).
H—Habbaniyah Lake.
J—River Tigris at Baghdad above Diala River.
K—Diala weir.
L—Abadan Island.
M—Kuwait on Persian Gulf.

Fig. 1—Scale Model of Part of Iraq

stereo plotting machine. Another interesting project was a map of the East Grinstead district to a scale of 1 in 1250, the purpose of which was to display a development site before acceptance of a proposed plan. Building details were extracted from the architect's drawings, contours and existing

details having been supplied from a contoured map in the possession of the architect. Models of industrial buildings to a large scale, say, 1 in 300, are extremely useful for studying the layout of an industrial process and for showing up the relationship between the layout of the proposed factory and the surrounding countryside.

Contour Relief Map of Iraq

The scale model is particularly valuable when it can be used to display in a comparatively small space a large expanse of country in which irrigation and flood control schemes are being studied with a view to far-reaching future developments. In this connection the author was recently favoured by an interview with Mr. J. S. Turcan, A.M.I.C.E., an irrigation engineer of wide experience, who supplied him with particulars of a contour relief map (Figs. 1, 2 and 3) of a large area of land in Iraq, presenting to scale the natural features and levels of the irrigated lands of that country, the main rivers passing these lands and the irrigation systems serving them.

After some years of service in that country Mr. Turcan was impressed by the fact that there was no suitable map available which could be referred to when discussing the flow of the main rivers in their passage through the plains. There were numerous uncontoured maps to a metric scale, but they were too small for useful application and were also out of date, so that they were not suitable for studying the irrigation system as it then existed. There were also $\frac{1}{4}$in to the mile military maps covering most of the country with distances shown in miles, and as they were made on the grid system they were very useful to travellers. Many of the canals shown on these maps, however, had been abandoned since the maps were made, so that tracing of the irrigation systems and bringing them up to date was a laborious process, more particularly for those unfamiliar with the terrain.

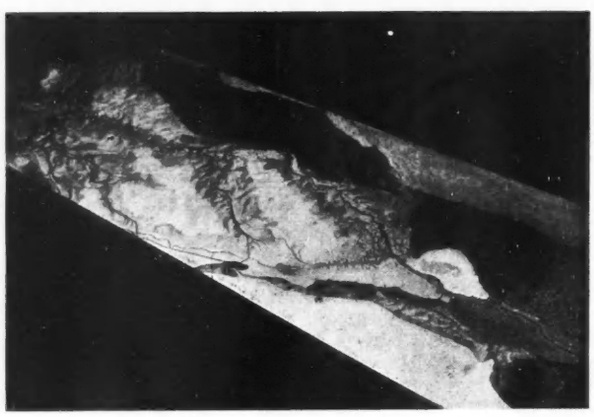
Spot levels in feet above datum had been recorded on many portions of these maps, but having been provided for the aid of military observers, they were not of much value to the irrigation engineer. The Survey Department of Iraq produced excellent contoured maps of the country, mainly on the 1 in 20,000 and 1 in 50,000 scales, and Mr. Turcan found that they were indispensable when he was studying irrigation problems in detail. When dealing with large projects in their initial stages, he found that the assembly of even the 1 in 50,000 scale maps may occupy too much space for convenient study in an office of average size, and also that a mass of detail is not necessary at this preliminary stage of the work. Moreover, there were at the time of construction of this relief model large areas of land under irrigation, for which these maps were not available, and about which Mr. Turcan had to seek for information from district irrigation officers, who had much local knowledge of the surveys made by the department from time to time. Some of these maps were to a different scale from those mentioned above and in one important area they were based on a different grid system from that now adopted by the Survey Department.

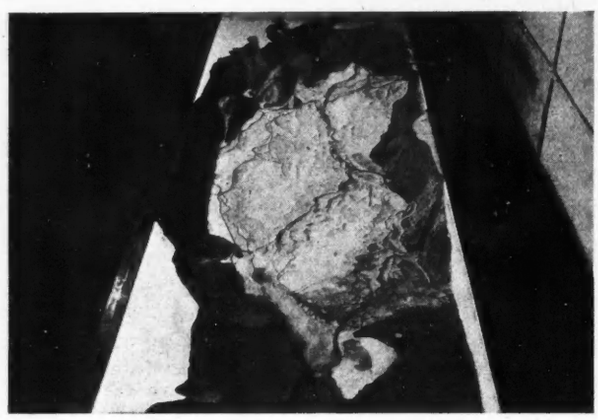
Finally, there were large tracts of land suitable for irrigation which had not yet been surveyed. When the Survey Department has extended its grip over the whole country it is expected that it will produce a contoured map of handy size, which will give all the information required, but it is believed that this will not happen for some years. Mr. Turcan therefore found that it was extremely difficult for anyone to obtain a clear picture of the rivers of Iraq in flood, and he therefore aimed at producing a contoured map which would show to a convenient scale all the leading features and levels of the country. The model has been constructed to a high degree of accuracy, and it is believed that it will be of great value until the surveys now in progress are completed.

A special method of construction was evolved for this model, and it was decided to employ a scale of 1 in 250,000, a reduction of the $\frac{1}{4}$in to the mile military map. Limits of the area to be shown on the model were approximately from Baija on the Tigris to the Persian Gulf; they include the weir on the River Diala in the east and the Abbu Dibbis depression on the west. Levels were limited from mean sea level to plus 100m and any heights above this which came inside the model were disregarded; the area of the model is 3·00m by 1·00m, corresponding to an actual land area of 750km by 250km. The major axis of the model is parallel to the line joining Baghdad and Basra.

The first stage in making the model was to join together a set of sheets of the 1 in 250,000 scale maps trimmed to the above limits, and the sheet thus formed was finally gummed to the inside of the lid of the box protecting the model, used as the key map by means of which all places and contours can be seen clearly. This key map was gridded in 20cm squares. In order to bring out the difference in level of irrigated lakes in such flat country it was necessary to distort the vertical scale considerably, Since it was desirable to show the 1m contours, and since 2mm was the smallest step that could be conveniently made on the vertical scale, the latter was fixed at 2mm to 1m, or a scale of 1 in 500. This represented a distortion in the vertical sense of 500 to 1. The foothills appeared to be extremely steep and this was borne in mind when studying sites for proposed reservoirs at Wadi Tharthar, Habbaniyah and Abbu Dibbis.

In forming the surface of the model, the first step was to reduce the survey contours to the scale of the model and, in this, discretion was used in omitting certain variations of levels which could not be shown on the model and therefore only important changes were indicated by the 1m contours. In preparing the model the following surveys were included :—All survey contour maps and maps of the Irrigation Department; recently completed surveys of the Irrigation Development Commission; railway surveys and any relevant survey information of recent date which might have been useful.





Figs. 2 and 3—Two Views of the Relief Model of Part of Iraq

Spot levels derived from the $\frac{1}{4}$in map were used in modelling the mountains, and by tracing ancient irrigation channels a good idea could be gained of the levels of adjacent built-up land and the probable slopes of the rivers could be estimated.

A heavy frame was made for the model consisting of welded and braced angle irons, and three brass wheels were fitted to each side of it. On this frame a dovetailed platform of teak $1\frac{1}{4}$in thick was fixed, upon the surface of which was moulded a 1in thick slab of reinforced concrete. The slab was boxed in by sides of twenty-ply wood, with the top edges of the latter 21cm above the concrete base, representing on the full size a height of 105m above the concrete. The mean sea level, or the datum level for the model is therefore 1cm above the concrete, and the extra centimetre provides a margin of 5m below sea level in order to enable the lowest part of the Wadi Tharthar depression to be presented on the model.

The model has been moulded in white Portland cement where the land is commanded by rivers, and grey Portland cement is employed for modelling deserts and mountains. A small amount of lime putty was mixed with the cement in order to facilitate working and to provide smooth modelling of the finished surface. The first step was to cast concrete slabs each 20cm square by 1cm thick, corresponding to the squares into which the total area of the map was divided. The borders of these concrete slabs were then secured in a frame of four brass strips which could be clamped together by wing nuts, so that when the slab was held the top of the strips was 2cm above the surface of the slab, representing a 10m rise in height on the vertical scale.

The contours contained within a 20cm by 20cm square were then traced on tracing cloth, the latter was cut to size, and the lowest contour was traced through carbon paper on to the white surface of the slab. The contour limit was then contained by a strip of plasticine 2mm thick and the cement mixture was poured against it, this filling up all the area inside the frame above the contour. When this had set sufficiently hard, the next contour was traced, and so on until all the contours within that particular area had been constructed; the plate then showed each rise of a metre by a 2mm step. In order to obtain overall control of the levels, a gauge was used reading downwards from the top edge of the frame; this consisted of a simple bridge spanning the width of the frame, with a graduated draw point which could be readily adjusted to the correct level. A coin 2mm thick could be used as a rough check on the thickness of each step when pouring the cement, but the above gauge ensured that the necessary accuracy of levelling was achieved over the model as a whole, and also that the contours had been correctly modelled from the maps.

When all the individual sections had been completed, they were assembled in the frame, their correct height being determined by a large spirit level used in conjunction with a bench mark on the model. Some of the sections were brought to their correct height resting on small walls of cement, so that part of the inside of the model is hollow, and this, of course, is an advantage where such a model has to be transported from place to place, as this kind of thing may be cumbersome and heavy. The mountains were mostly modelled in 5m contours, and in some cases nails were driven to give the heights shown by spot levels on the maps.

At this stage the appearance of the model was a series of 2mm steps for the flat land and of 10mm steps for the mountains. Where there were canals and similar features, the steps were blanked out by smoothing over with white cement, mountain and desert areas having been made more realistic in the same manner.

Pigments of various colours were ground up with the white cement and floated over the surface of the model to indicate the following:—Irrigated crops in summer and winter; rice lands; lands over which the water has to be pumped; date groves; areas liable to flooding, to swamps and to being covered by the sea. On the model white areas indicate land which can be developed. Roads and railways are indicated by coloured threads, the major canals by inlaid blue lines, and branch canals have been painted in oil colours. Large towns are shown by flags, and this is a good idea because names printed on such a map are apt to become confusing; in any case, the key map inside the lid of the model was always available for reference.

The level gauge spanning across the frame of the model, not shown in the photographs, comprises two stiff strips of plywood on the top of which is mounted a mobile carriage, carrying a thin strip of plywood graduated from zero datum level to 100m above datum on the vertical scale; this strip is lightly held in position by a recessed spring fixed in the carriage and pressing against the strip. The lower end of this strip finishes in a point, and when this is lowered, say, to sea level on the model, the zero level can be read on a pointer fixed to the carriage. Thus, in order to obtain any level, it is merely necessary to run the gauge over the place required and to lower the point upon it. Similarly, to find any place on the model from the map, measurements along the grid line of the map can be transferred to the sides of the box. The gauge is then set on this distance and cross measurements can be made along the bridge of the depth gauge.

As Mr. Turcan explained to the author all the projects set out in the report of the Irrigation Development Commission can be studied on the model in a general way. The model is accurate enough to be able to judge from it the practicability or otherwise of the present canal system. He has also pointed out another very important advantage of such a model, namely, that it provides a very good idea of the complicated behaviour of rivers in flood and is, therefore, extremely valuable to those engineers who may have to make very important decisions affecting large areas of country. A map of this kind is equally valuable for students and for qualified engineers.

Scale Model of Malmo Harbour

In recent years there has been a tremendous development in the application of scale model techniques to the solution of problems concerning dock and harbour projects, where decisions taken frequently entail the expenditure of very large capital sums, so that money spent on a model will be put to good advantage if it provides the necessary information in a reasonable period of time. Many engineers are doubtful of the value of experiments carried out on small-scale models of ports subjected to the influence of complicated currents and changing barometric pressure. Some contend that distortion between horizontal and vertical scales of the model and the particle size of the bed material, or of the solids in suspension in the water used in the model, throw all calculations out of gear in respect of what actually happens in nature. Although there may be some truth in this contention, there is no doubt that if the problem is approached in a scientific and thoroughly practical manner, it can be elucidated satisfactorily with the aid of such a model and this has been proved in many instances.

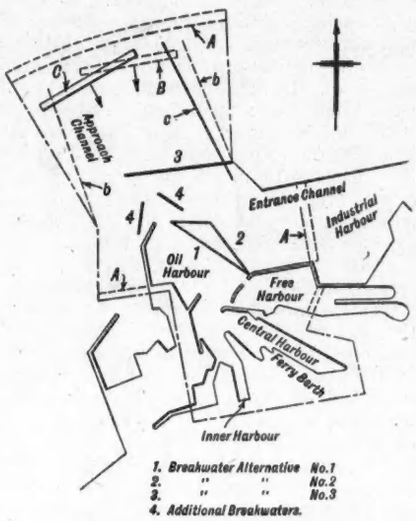


Fig. 4—Layout of Malmo Harbour Model

Model technique shows up to particular advantage when studying the relative merits of different layouts of quays and breakwaters, because it demonstrates the effect of placing such works at different angles and in different places, enabling alternative estimates to be prepared within reasonably close limits of the various works proposed. The sketch (Fig. 4) shows the layout of a very interesting and useful scale model employed by Professor Hellstrom for his study of Malmo Harbour, Sweden ("Model Tests for Malmo Harbour," by B. Hellstrom, M.I.C.E., D.Eng., Professor of Hydraulics at the Royal Institute of Technology, Stockholm: *The Dock and Harbour Authority*, October, 1950). The present harbour entrance has proved to be unsuitable from the navigation point of view, and large ships like the Copenhagen train ferry "Malmohus" find difficulty in negotiating the present entrance, particularly when strong currents are flowing. Under certain conditions there is also a troublesome sea in the oil harbour. The model tests have been mainly concerned with two problems, namely, to determine the effect on waves in the inner part of the harbour due to widening of the harbour entrance, and to find the most suitable position for a new breakwater to improve wave conditions in the oil harbour and in the central harbour.

The tests were carried out during 1947-48 at the Institution of Hydraulics of the Royal Institute of Technology in Stockholm. Wind records dating back to 1900 taken at Malmo showed that it was necessary to allow for a wind velocity of up to 65 m.p.h. in directions varying from N.W. to N., since these directions gave the worst wave conditions in the harbour. In autumn, 1947, during a wind of 20 m.p.h. at Malmo, the lengths, heights and periods of the waves were measured at nine different places in the harbour. These measurements were then used as a basis for comparison between waves on the model and waves in nature. In the model two kinds of waves were used, corresponding to winds of 31 m.p.h. and 47 m.p.h., approaching respectively from 327 deg. and 347 deg.—that is, as raised by winds between N.W. and N. Continuous records of the height of the water level in the harbour indicate that there is no surge and a tide of only 6in which was neglected in the tests.

A horizontal scale of 1 in 100 was chosen for the model. In shallow water the velocity of the waves is dependent upon the depth, so that in this case it is desirable not to have any distortion of scale, and therefore the vertical scale was also 1 in 100. The model was built of concrete on top of sand filling, with quays and end walls of ordinary bricks. To prevent disturbance due to wave reflection from the side walls of the model, slopes of broken stone at 1 in 5 were arranged at *A* (Fig. 4); *B* and *C* show the wave generator in alternative positions, the letters *b* and *c* indicating the screens for these respective wave generating positions. The harbour entrance, breakwaters to be tested and parts of the bottom were made separately of movable concrete blocks. Waves were generated by a rotating eccentric cylinder; by changing the rotational velocity and eccentricity, wave period and wave height respectively could be altered to a certain extent. Movable screens *b* and *c* were used in addition to the slopes of broken stone in order to avoid reflection of approaching waves from the sides of the model.

Wavelength on the model was determined from photographs taken against a screen subdivided by a grid, the heights and periods of the waves being measured by means of specially constructed electric gauges connected to a suitable oscillograph. Such measuring devices were required in order to obtain clear continuous records of the waves, the smallest of which had an amplitude of less than 1mm. The electrical gauge consisted of two vertical brass wires, ½mm diameter and set at 10mm centres, insulated from each other and stretched on a frame of insulating material. This frame was made of Perspex or Plexiglass, which proved to be

somewhat hygroscopic and therefore became electrically conductive; for this reason it was effectively waterproofed by a skin of paraffin wax.

By connecting the gauge in series with an alternating current supply and an oscillograph and by immersing a part of the gauge in the fresh water in the model, a circuit was completed; when the waves in the model passed the gauge the water level rose and fell and the length of the water column between the two vertical wires varied with the wave motion. Consequently, the circuit resistance of the water between the wires and thus the current in the circuit varied with the waves. These variations were registered by the oscillograph in which reflecting galvanometers recorded the variation of water level on a photographic paper tape, the oscillogram giving the profile of the waves. Ratios between wave height on the oscillogram and in the model had to be determined by calibration, which was done in the following manner. The electrical gauge was fixed to an adjustable point gauge with a vertical scale marked in 0·10mm divisions and lowered by steps of 1mm, an oscillogram being taken for each step. The relationship between amplitude on the oscillograph and wave height was found to be linear.

An alternating current of 50 cycles per second periodicity was used and this frequency was found sufficient to avoid any disturbing production of gas at the electrodes. The alternating current gave diagrams made up of a series of zigzags, the envelope of the tops of these giving the wave profile. It is interesting to note that the surface of the model was made of cement mortar and that salts from it dissolved and changed the electrical resistance of the water, so that the change of the calibration constant, or the ratio between the wave height in the model and the wave height on the oscillogram amounted to about 1 per cent from day to day. Calibration had therefore to be made every day that the model was used.

Sensitivity of the measuring apparatus was controlled by adjusting the depth of immersion of the gauge in the water, and by adjusting the current in the measuring circuit by means of a variable resistance, so that the full height of the tape in the oscillograph could be used. A maximum amplitude of about 50mm on the oscillogram could be employed for registering wave heights of 1mm as well as of 100mm, wave period being determined directly from a time indication on the oscillogram. Wave heights in the model were measured at a fixed water level for different widths of the harbour entrance and for different breakwater alternatives. Widths of the harbour entrance and positions of the breakwaters were changed during the tests without stopping the wave-producing machinery, so that incoming waves remained unchanged from one test to another.

In a harbour of such irregular shape wave formations are bound to be extremely complicated. Therefore is was found necessary to register about 1000 waves at each test, of which the largest 200 were selected and measured and their average height was taken as a figure for comparison between the different tests. Widening of the harbour entrance was made by shortening the eastern breakwater, and the influence of this width on wave height was studied and recorded at three different widths, at 230ft (the present width), 330ft and 390ft. At each width nine tests with different kinds of wave combined with different approach directions of waves were carried out. Wave heights were measured at the entrance to the inner harbour, in the southern part of the inner harbour and at the ferry berth.

Test results indicate that the wave height in the harbour does not increase in proportion to the width of the harbour entrance. An increase from 230ft to 330ft is estimated to increase the wave height by 25 to 40 per cent, while widening to 390ft will increase wave height by 45 to 70 per cent; it is considered that the larger figures of 40 and 70 per cent are extreme values and are not likely to occur in practice.

Four different breakwater alternatives were tested. The first one consisted of a straight breakwater from the northern pierhead at the entrance of the Free Port to a point 425ft east-north-east of the pierhead north of the oil harbour. The second alternative was a breakwater with its ends in the same positions as those for the first alternative, but it was given an angular shape to allow for a quick spreading of incoming waves. The third alternative used the same breakwater as the second and, in addition, two short island breakwaters outside the entrance to the oil harbour, one on each side of the entrance. The fourth alternative was an extension to the west of the existing breakwater north of the entrance channel to the industrial harbour.

At each breakwater alternative, five tests were made with different wave types in combination with different directions of approaching waves. In these cases measurements of wave heights were taken in the oil harbour, in the harbour entrance, in the inner harbour, and at the ferry berth. Results have proved that the fourth alternative gave the best solution for reducing waves in the harbour; moreover, a breakwater in this position was found to give minimum cost of construction in proportion to its effect, despite the increased depth of water. As it would also give a good protection to the entrance channel to the industrial harbour, this alternative indicates the most suitable position and extent of a new outer breakwater. A combination of the results from the tests with different widths of the harbour entrance and the results of the breakwater tests shows that the entrance can be widened from 230ft to 330ft or 390ft without deterioration of wave conditions in the harbour if a breakwater as in the fourth alternative is being built.

Many engineers are inclined to be sceptical about the value of experiments carried out on small-scale models of ports subjected to the influence of conflicting currents and varying barometric pressure. The answer to this probably is that the results of model experiments must be interpreted with skill by engineers who thoroughly understand the various actions which go on in a harbour under wave action and similar influences. In other words, model experiments carried out without due consideration for practical effects will be doomed to failure.

Ship Models

The use of ship models is now a well-established technique which owes so much to the pioneering work of William Froude, in honour of whom a ship model testing tank was presented to the National Physical Laboratory by the late Sir Alfred Yarrow. The first ship model testing tank in the world was started in 1871, based on the principle laid down by Froude that frictional force varied with the amount and nature of the wetted surface, rate of increase being nearly proportional to a power rather less than the square of the speed. To-day every new design for ships is tested in model form and a tremendous background of very valuable knowledge and experience has been built up.

The Admiralty have taken full advantage of all the benefits to be derived from model experiments, and the most remarkable work that they have yet done, in the author's opinion, has been concerned with tests on radio-controlled ship models by S. G. Lankester and S. G. Dreier, of the Admiralty Experiment Works. They have used free self-propelled models for steering investigations in the development of improved types of rudders for destroyers and motor torpedo boats. For the steering investigations electrically propelled wooden models up to 26ft long are run in Horsea Lake, and until recently these were controlled either by a human helmsman or by a special time clock. The most recent development is a form of radio remote control, already fully described in these columns.

(To be continued)

Nimonic 95

In order to meet the steadily increasing demands of gas turbine engineers for materials which will withstand still higher temperatures and higher stresses than the alloys used in current production engines, the research metallurgists of the Mond Nickel Company, Ltd., have continued their investigations in the field of precipitation hardening nickel-chromium alloys. The latest outcome of these investigations is the alloy Nimonic 95 which has recently been announced. The new alloy is similar to Nimonic 90, but the creep-resistance at elevated temperatures has been improved by increasing the content of the hardening elements.

All alloys which have high creep-resistance at high temperatures are necessarily difficult to hot-work, and one of the major problems in the development of a new alloy is to maintain sufficient forgeability to enable the material to be worked to the required form. Any increase in the maximum temperature at which an alloy is serviceable necessarily involves a reduction in the temperature interval within which hot-working must be carried out, for the increase in the amount of alloying elements does not usually produce at the same time an increase in the melting point of the alloy. Nevertheless, by careful control of the proportions of the hardening elements and of the methods of melting and casting of ingots, as well as by improvements in the technique of hot-working, it has been found possible with Nimonic 95 to maintain adequate forgeability.

Since Nimonic 95 has only been developed within the last few months, it has not yet been possible to determine its creep properties in long-time tests or over a wide range of temperatures, but its properties for the relatively short periods which are of major interest for aircraft jet engines, show a considerable improvement over those for Nimonic 90. The properties are summarised in the following table, which gives the stress required to produce fracture in 100 hours at temperatures between 750 and 925 deg. Cent., and the approximate minimum creep rate for tests at that stress:—

Temperature deg. Cent.	Stress to rupture in 100 hours, tons per square inch	Approximate minimum Creep rate for 100-hour test, per cent per hour
750	22	0·002—0·005
815	14	0·002—0·005
870	9	0·002—0·005
900	6·5	0·005—0·01
925	5·0	0·005—0·01

Tests are in hand to extend the knowledge of the creep resistance of the new alloy and to determine other properties of importance to designers, but in the meantime it is being produced by Henry Wiggin and Co., Ltd., and is being used in experimental quantities by engine builders.

Technical Reports

The Pressure Generated During Explosion Inside a Core-Cooled Motor (Research Report No. 38). By H. Staples. Safety in Mines Research Establishment, Sheffield. Price 1s. 3d.—This report continues the account of experiments carried out in a large core-cooled motor, the earlier work—recorded in Reports Nos. 11 and 27—having been concerned with explosions of pentane-air mixtures. The work is now being continued with mixtures of methane in air and of hydrogen/methane in air. It has shown that the explosion is most violent when the motor is driven at full speed, and the highest pressure generated in the explosion of methane and air is then much lower than the peak pressure of a hydrogen/methane-air explosion. The latter pressure does not differ greatly from the value obtained with a pentane-air mixture.

British India Liner "Uganda"

No. II—(*Concluded from page 166, August 1st*)

The British India Steam Navigation Company, Ltd., has recently taken delivery of the S.S. "Uganda," a sister ship to the S.S. "Kenya," which made her maiden voyage last year. Both vessels are engaged in the company's service from the United Kingdom to East African ports and the "Uganda" which has a tonnage of about 14,500, and carries a total of 300 passengers, is propelled, at a service speed of 16 knots, by twin screws. The machinery consists of two sets of single-reduction geared turbines of 11,200 s.h.p., taking steam at 430 lb per square inch pressure and 750 deg. Fah.

Propelling Machinery

THE accompanying drawing and illustrations show the general arrangement of the engine and boiler-rooms and the generator compartment. The ship is powered by two sets of the latest design of Parsons steam turbines taking steam at a pressure of 430 lb per square inch gauge and a temperature of 750 deg. Fah., and developing a total normal ahead power of 11,200 s.h.p. at propeller revolutions of 125 r.p.m. and a maximum of 12,300 s.h.p. at propeller revolutions of about 129 r.p.m. The astern turbines are designed to give 65 per cent of the service power and to take steam at 430 lb per square inch and 750 deg. Fah., but a desuperheater is fitted in the steam drum of the boilers to reduce the final steam temperature to 600 deg. Fah. Each set of engines consists of h.p., i.p. and l.p. turbines, the h.p. turbine being of impulse-reaction design, the reaction blading being end tightened. The i.p. and l.p. turbines are fitted with reaction blading, all of which is end tightened in the i.p. turbine. A nozzle belt is fitted for use when the maximum shaft horsepower is required. The astern turbines consist of an h.p. impulse wheel incorporated in the i.p. ahead casing and separated from it by a diaphragm and an l.p. turbine fitted at the exhaust end of the l.p. ahead turbine.

All the blading is of stainless iron and the turbine casings are of cast steel. Cockburn's manœuvring valves are fitted, the ahead and astern valves being in one casting, and there is a master shut-off valve on the astern range. Aspinall cut-out governors are supplied and operate through the forced lubrication system, and the steam is shut off should the oil supply fail or the turbine speed exceed a set limit or the vacuum in the condenser fall below a safe limit. Each turbine casing has double-pocket steam glands connected to gland steam condensers.

Single reduction, double helical gearing is fitted and each set of three turbines drives a main gear wheel, which has a pitch circle diameter of 160·9in, a helix angle of 29 deg., and a cast iron centre with shrunk-on forged steel rims, through forged steel pinions, each of similar diameter. The gear ratio is such that when the propeller is running at 125 r.p.m. the turbine speeds are 3240 r.p.m., and the forged mild steel shafting has diameters of 15in for the intermediate shafting and 16¾in for the tail shafts. Four-bladed built-up variable pitch propellers have been provided by Bull's Metal and Melloid Company, Ltd., and they have a diameter of 16·3ft by 15·5ft mean pitch, a cast steel boss and bronze blades. Electrical torsionmeters measure the power delivered to the propellers. For manœuvring, propeller revolutions of 90 r.p.m. are estimated to give a speed of 13·1 knots and 60 r.p.m. to give 8·7 knots, while 40 r.p.m. give 5·8 knots. "Vertoil" oil pumps each of 16,000 gallons per minute capacity, circulate the lubricating oil through "Serck" oil coolers and Auto-Klean strainers.

Three Babcock and Wilcox oil-fired water-tube boilers supply steam at a pressure of 450 lb per square inch gauge and a superheat of 750 deg. Fah., which is controlled down to 600 deg. Fah. by an oil relay system and a cock at the starting platform, relay valves in the boiler-room admitting steam to the desuperheaters to reduce the temperature. The total heating surface of the installation is 21,117 square feet.

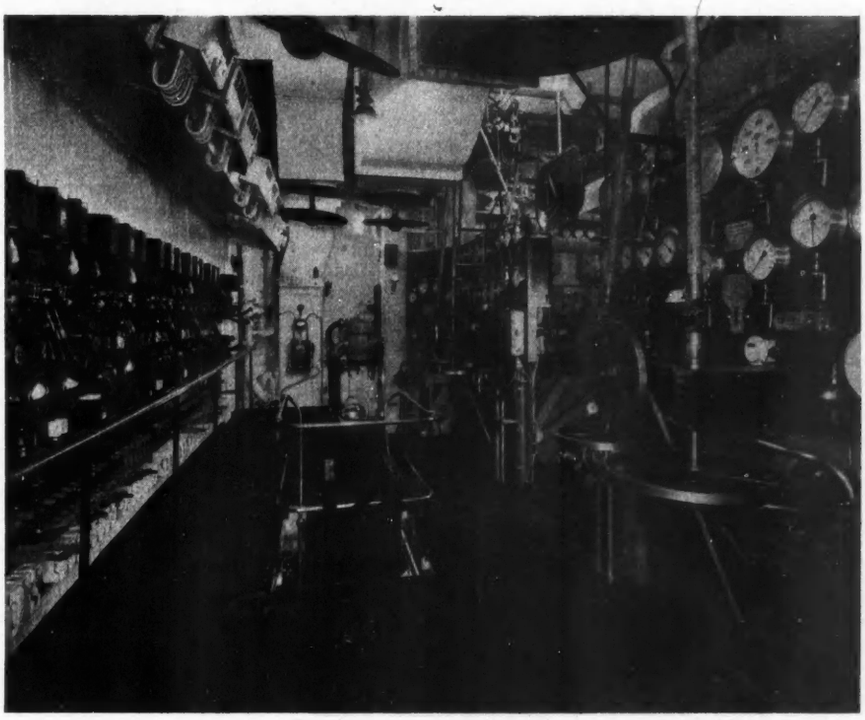
Howden's balanced system of forced draught is maintained by three electrically driven fans, one for each boiler, and a single induced draught fan which is capable of dealing with the waste gases from all three boilers at maximum evaporation. The forced draught fans are each rated to supply 12,500 cubic feet of air per minute at 80 deg. Fah. against a pressure of 6·5in water gauge, and the induced draught fan deals with 59,000 cubic feet per minute at 350 deg. Fah. against a pressure difference of 2·9in water gauge. The waste gases are discharged through a Howden's up-flow vortex dry pattern dust collector, mounted in the funnel which is 12ft higher than that of the "Kenya." The grit and soot collected are discharged into a hopper which is flushed with sea water, and the mixture is led overboard at a point below sea level through special armoured rubber hose, rubber being used because of the strong corrosive action of the mixture of soot and salt water.

Vertical tubular air heaters, providing a surface of 4560 square feet for each boiler, are fitted in the uptakes and are provided with by-pass arrangements for slow steaming. Wallsend oil fuel equipment is fitted and two Weir fuel oil transfer pumps of 50 tons per hour capacity at 50ft head, and also an oil-fired Cochran auxiliary boiler. The boilers are fitted with CO_2 recorders and "Igema" long-distance reading water level indicators, while one boiler is equipped with a Dewrance patent bi-colour illuminated water level indicator.

Closed Feed System

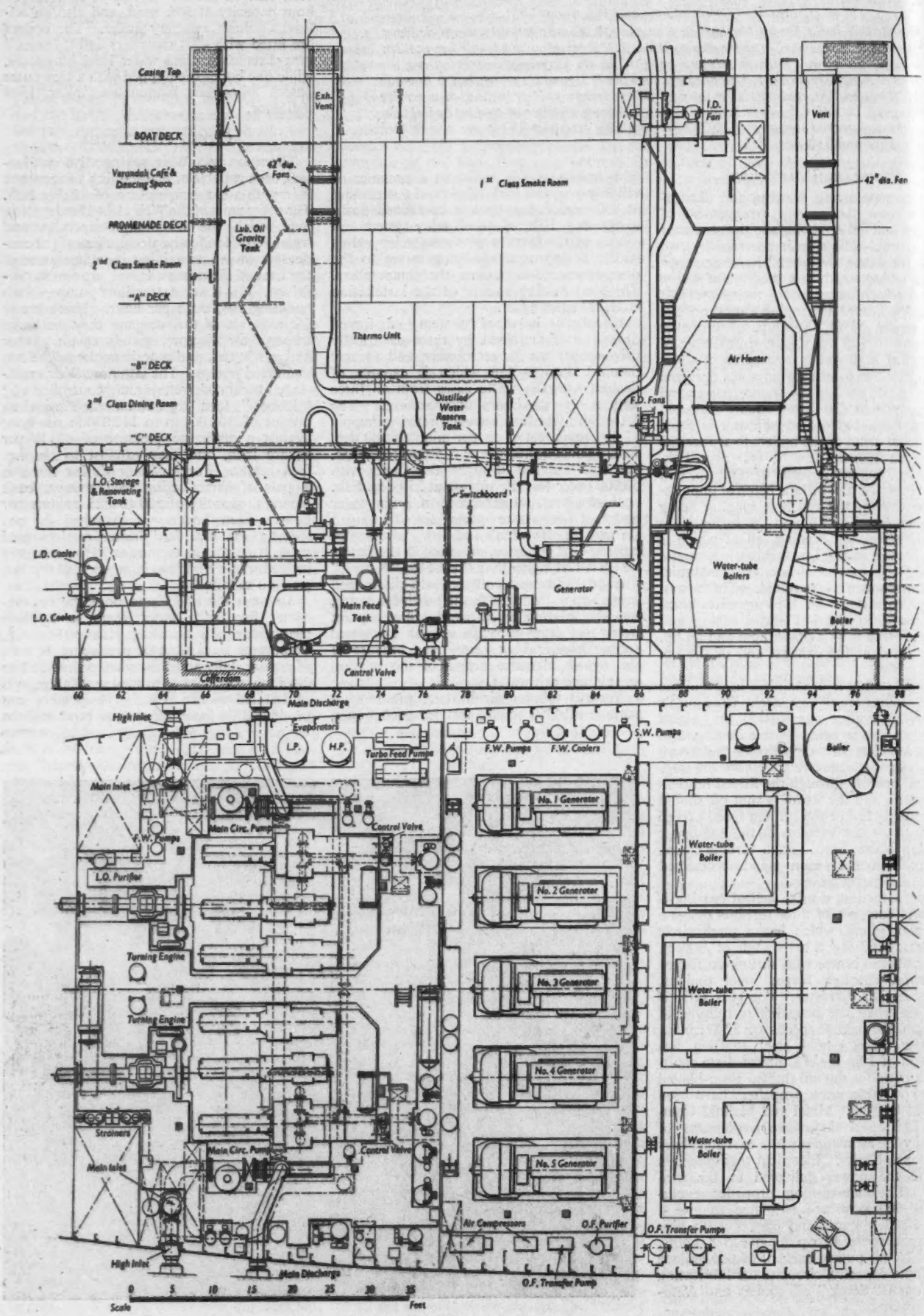
There are two Weir regenerative condensers, each capable of maintaining a vacuum of 28in with a sea temperature of 82 deg. Fah. The other units of the Weir closed feed system, over which the installation operates and which ensures effective de-aeration of the condensate while maintaining its temperature at the heat of the exhaust steam, are two motor-driven, low-heat extraction pumps, each handling 108,000 lb per hour. There is one for each set of turbines and they discharge through air ejectors, glands steam ejector and condenser, and a drain cooler to the two main feed pumps. The latter are Weir multi-stage turbine-driven units controlled by "Robot" feed regulators, each with an output of 108,000 lb to 140,000 lb per hour against a discharge pressure of 600 lb per square inch, and they exhaust to the l.p. feed heater. For auxiliary duties there is a pair of direct-acting feed pumps, each having a capacity of 500 to 625 gallons per hour. Feed heating is arranged in two stages; the h.p. feed heater receives bled steam from the i.p. turbine at 90 lb per square inch absolute and this is augmented by live steam if required.

To meet the boiler and domestic requirements for fresh water there is a Weir evaporator and distilling plant. The h.p. evaporator is capable of producing 40 tons of vapour daily and this, when passed to two distilling condensers, produces 9000 gallons of distilled water. The l.p. evaporator can produce 3730 lb of vapour per hour and the



Starting Platform and Switchboard

MACHINERY LAYOUT ON S.S. "UGANDA"



steam generator is rated at 43 tons of vapour daily.

Auxiliaries

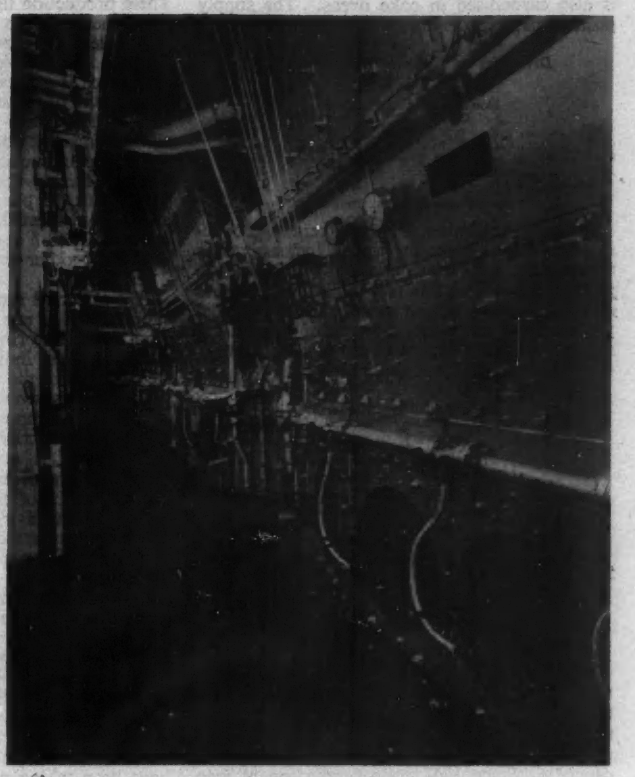
The two main circulating pumps, each having a capacity of 12,500 gallons per minute, are electrically driven by 50/140 b.h.p. motors. These and the pumps required for ballast, bilge and fire, general service, fresh water, salt water and sanitary services, are all by Drysdale and Co., Ltd., and driven by Allen electric motors. The ballast pump is rated at 300 tons per hour at 60ft head, the fire and bilge pumps can deliver 140 tons per hour at 80ft head, and the rating for the sanitary pumps is 90 tons per hour at 150ft head, while the fresh water pumps supply 20 tons per hour at 120ft head.

To prevent the discharge (from those pumps which discharge overboard in way of the lifeboats) from flooding the boats when being lowered in an emergency, a push button control has been fitted in a suitable position on the boat deck so that the pumps can be stopped. The hot and cold fresh water supply operates on the Drysdale "Pneupress" system, the two pumps supplying the water being automatically controlled, and should one pump be unable to meet the demand then the second pump automatically comes into action. A salt water supply tank is fitted in the ship at a height sufficient to ensure delivery to any tap, and the sanitary pumps are automatically started and stopped by the water level in the tank.

The power for the motors of the engine-room pumps, the steering gear, the deck machinery, the galley, laundry, other domestic services, and the ship's lighting is supplied by five diesel generators, supplied by W. H. Allen, Sons and Co., Ltd., each having a twelve-hour rating of 390kW, 220V d.c. They are arranged transversely across the ship in a separate generator room placed between the boiler and engine-rooms, with an easily accessible switchboard fitted in the engine-room on the same level as the starting platform. Three generators are adequate to meet the maximum demands for power, so that the two standby units provide an ample reserve against contingencies. The emergency generator, of 50kW capacity, supplied by Sunderland Forge and Engineering Company, Ltd., is driven by a five-cylinder Ruston and Hornsby diesel engine, and located in the officers' deckhouse on the boat deck.

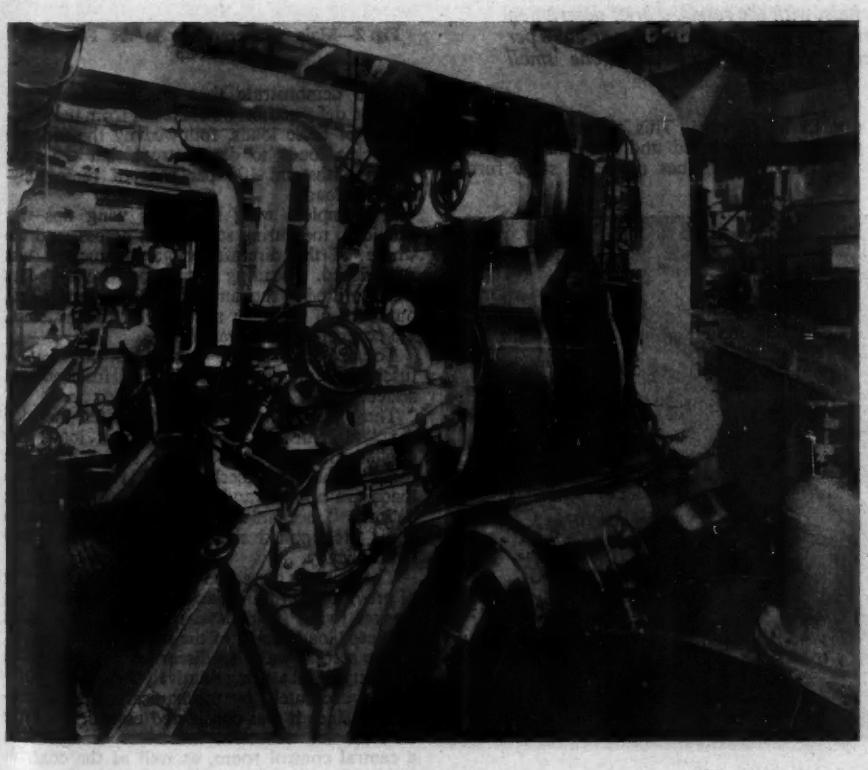
For ventilating the machinery spaces Thermotank fans and trunking have been fitted. Four torpedo-pattern motor-driven fans, each capable of delivering 20,000 cubic feet of air per minute against 1½in water gauge, supply the engine-room and the generator room, while one extraction fan removes the foul air from the latter compartment. Two fans of 20,000 cubic feet per minute capacity supply the necessary air to the boiler-room.

Particular precautions have been taken against any outbreak of fire in the machinery spaces. A "Pyrene" fire foam system is fitted in the boiler-room and two 30 gallon capacity engines, together with portable extinguishers, are available for dealing with any small outbreaks. Geared dampers are fitted in each ventilation trunk so that the air supply can be cut off, and the operating gear is placed outside the spaces so that it is always accessible. As another safeguard, any oil escaping from pipes or tanks in the machinery rooms, can be controlled by means of quick-closing valves which can be immediately shut from an outside position.



Boiler Room

J. and E. Hall, Ltd., has supplied the refrigeration machinery consisting of three single-acting, twin-cylinder CO_2 compressors having 3¼in bore by 7in stroke, each driven by a Laurence Scott electric motor of 78 b.h.p. at a maximum of 425 r.p.m. Two machines serve the refrigerated cargo spaces and stores, while the third is required for the air-conditioning plant, which is capable of abstracting 450,000 B.Th.U.s when cooling brine from 51 deg. to 46 deg. Fah. at a rate of 8700 gallons per hour with sea water at 90 deg. Fah. On the same flat at the aft end of the engine-room is the sprinkler system tank of 1000-gallon capacity, and in the tunnel is located one of two sewage units supplied by Adams-Hydraulics, Ltd., the other unit being mounted in the boiler-room.



The Turbines

Coke Supplies for the Steel Industry*

The iron and steel industry is the largest user of coke in this country. The quantity needed to produce a ton of pig iron has been gradually reduced over a long period of years as the size of blast furnaces has been increased and additional ore preparation and sintering undertaken. But it still takes just over a ton of coke, on the average, to provide the fuel and the carbon monoxide gas needed to make a ton of pig iron. As iron production rises with the completion of new blast furnaces under the industry's second development plan, coke requirements will show a corresponding increase.

At present, about two-thirds of the steel industry's coke requirements are met by the output of its own ovens. Most of the remainder comes from ovens owned by the National Coal Board, but smaller quantities are also received from "independent" ovens. In recent years, moreover, small additional supplies have been received from the Beckton gas works, where coal

* From the British Iron and Steel Federation.

is also carbonised in coke ovens. The supply position has been as follows :—

Deliveries of Coke to Blast Furnaces

(Thousand tons)

	Iron and Steel Ovens	Other Ovens	Total
1948	6,381	4,028	10,409
1949	6,568	3,709	10,277
1950	6,607	3,611	10,218
1951	7,117	3,589	10,706
1952*	7,832	3,752	11,584

* Annual rate on first six months.

So far as steel making iron is concerned, production has tended in recent years to increase rather faster than coke consumption owing to the gradual improvement in fuel efficiency. Progress in this direction was, however, interrupted last year because the acute shortage of foreign ore made it necessary to increase very considerably the use of the leaner home ore :—

Basic and Hematite Iron

	Production	Coke Consumption	
		Total	Per ton of pig
	000 tons	000 tons	cwts
1938	5246	5746	21·9
1948	7622	7985	21·0
1949	7686	7895	20·5
1950	7955	8036	20·2
1951	8008	8346	20·8
1952*	8657	9076	21·0

* Annual rate on first six months.

The steel industry's general intention since the war has been to keep its purchases of coke from " outside " sources at a more or less stable figure and to meet the long term increase in its needs by an expansion of its own coke oven capacity. Since 1948 coke production at iron and steel ovens has been increased by about one-fifth, from 7,081,000 tons to an annual rate of 8,400,000 tons in the second quarter of this year. These production figures at iron and steel ovens are higher than the delivery figures shown in the first table. The reason is that part of the output consists of small coke unsuitable for blast furnace use, which is generally sold outside the industry. The growth of production at iron and steel ovens during the last two years results from the expansion of capacity under the industry's 1946 development plan, the time taken to build a coke oven battery having been about three-and-a-half years from the placing of the order. A further advance is expected this year, as expansion plans come to fruition at more plants. Since 1948 the output of other ovens has risen by just over 2 per cent.

It is apparent that a rapid expansion of coke supplies will be required over the next few years. Apart from the rising needs of other industrial users, the steel industry's requirements will rise steeply because the expansion of steel production must be based wholly on pig iron. The increase is not quite proportionate to the expansion of pig iron production, for further economies are expected. But compared with 1951, nearly 5,000,000 tons of extra coke (equivalent to over 7,000,000 tons of coking coal) will be needed if steel production is to rise to 20,000,000 tons. The intention is that virtually the whole of this increase shall be provided from the industry's own ovens.

A major problem is that of securing the necessary increase in supplies of coking coal. The steel industry alone will require an extra 7,000,000 tons for its coke ovens—and it is common knowledge that reserves of prime coking qualities are by no means superabundant. Though the expansion of production will not be easy, it should be possible, expecially in view of the recent improvement in the coal position generally. Discussions have been taking place with the National Coal Board with a view to safeguarding the extra supplies of coking coal without which the steel industry's development plans cannot be fulfilled.

Complete Wing Tests on the " Britannia " Airliner

Some further notes have been provided by the Bristol Aeroplane Company, Ltd., on the development of the " Britannia " airliner. These are mainly concerned with structural tests on a complete wing and include, with the result, a brief description of the test frame used. The wing, which originally failed in the front spar at 98 per cent ultimate design load under gust conditions, has since undergone small modifications.

STEADY progress is being maintained at Bristol on the construction of the two " Britannia " prototype airliners, the first of which is due to fly shortly. This aircraft, with engine nacelle fairings fitted and tailplane and outer wings in position, has moved a stage further forward in the " Britannia " assembly line, and the second machine has taken its place on the assembly jigs.

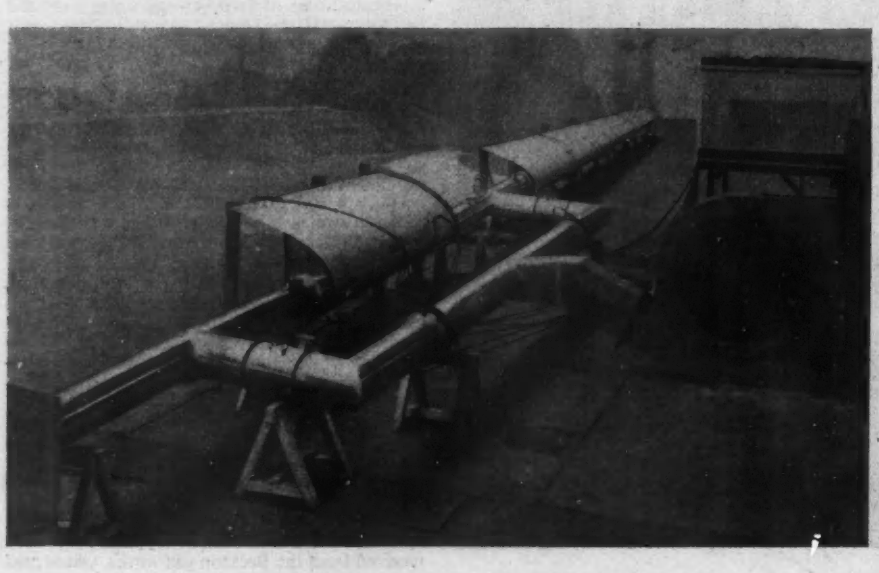


Fig. 1—Wing Thermal Anti-Icing Ducts Rig

Major Structural Tests

In recent years, the aircraft industry has turned increasingly to large-scale tests on complete aircraft components for proof of satisfactory design, and to ensure against structural troubles in service. The programme of major structural tests on the " Britannia " is, in fact, the largest the Bristol Company has ever undertaken. Three major specimens have been exhaustively tested—a complete wing, a half-scale rear fuselage mounted on stub wings, and a full scale front fuselage. Tests on the complete wing are the subject of these further notes on the development of this aircraft.

Examination of the loading cases in the design of the wing structure showed that the loads arising from the landing case and from the gust case might prove critical, the former as regards shear and torque in the inner wing, and the latter as regards most of the bending structure.

As only one specimen could be considered, it was agreed that the proof (66·6 per cent of ultimate) landing case loads should be applied first to demonstrate that no appreciable permanent deformation would result from the application of these loads, followed by the ultimate gust case loads to demonstrate that the wing would withstand 100 per cent of these fully-factored loads.

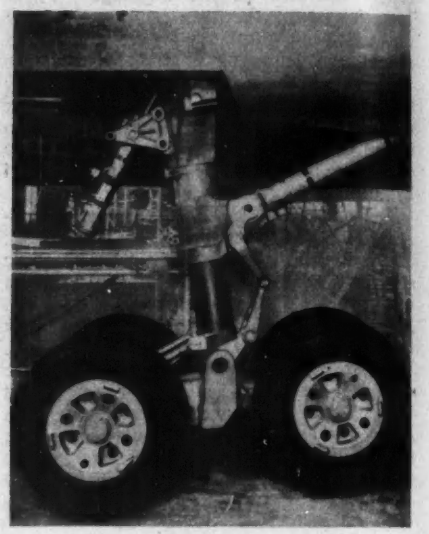


Fig. 2—Main Undercarriage in the Functional Mock-up

A complete wing span less wing tips was provided, measuring some 136ft across, and the whole of the aircraft primary structure was reproduced. Leading edges and trailing edges were omitted in the landing case but were added, outboard of the inner nacelles, for the gust case. No control surfaces were fitted.

To provide correct conditions at wing-to-fuselage joints, a 46ft length of fuselage was added.

The types of test frame investigated included the " all-hydraulic " rig, in which loads are applied and measured by one set of hydraulic jacks ; the " all-mechanical " rig, in which loads are applied and measured mechanically ; and the " mechanical-hydraulic " rig, in which loads are applied mechanically and measured hydraulically.

The first was discarded because of the difficulty of providing hydraulic jacks with sufficiently long strokes (wing tip deflection under the ultimate gust case loads being of the order of 7ft).

The second was also discarded because of the difficulty of measuring relatively large loads sufficiently accurately by mechanical means, particularly since it was considered essential to have all load and deflection indicators brought into a central control room, as well as the controls for load applications. The third, the " mecha-

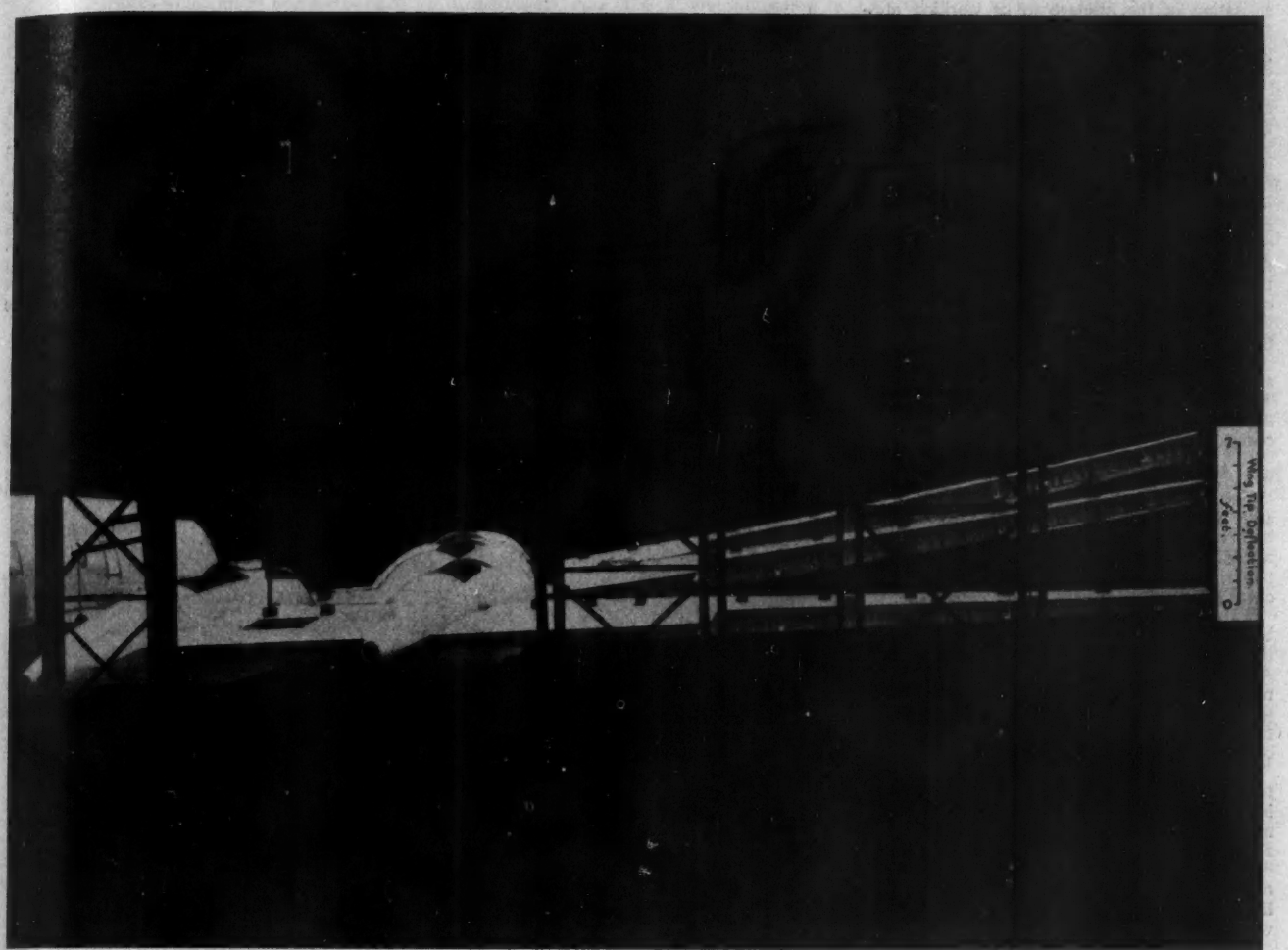


Fig. 3—Three Deflection Stages on Mock Wing

nical-hydraulic " loading principle, was finally adopted.

There are several details by which the period of one of our illustrations can be traced, but it is reproduced here to show what served forty years ago at the Bristol works.

The present rig, erected at the Bristol works in accordance with preferred policy, is similar to the well-known " Cathedral " test frame at the Royal Aircraft Establishment. It consists basically of a heavily reinforced stiff concrete raft upon which are mounted six portal frames which can be moved about within the limits of the raft to cater for varying wing configurations of the future.

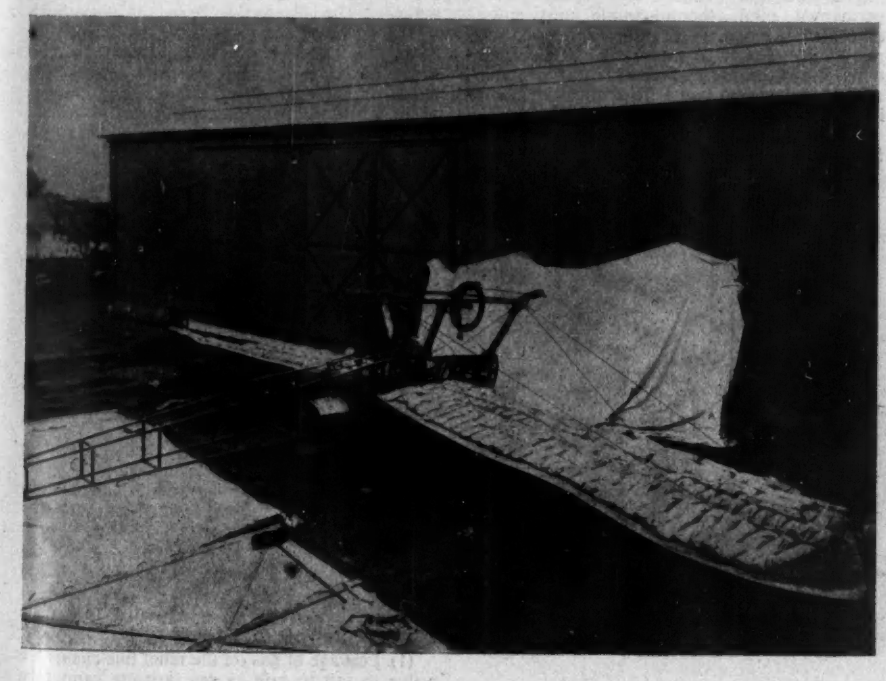


Fig. 4—Wing Testing at Bristol 40 years Ago

A mechanical straining unit is mounted on each portal frame, and consists of a horizontal pivoted beam, on which are mounted twin worm-driven straining screws, a four-speed gearbox, and an electric motor. The floating end of this pivot beam rests on a hydraulic compression jack which is connected to a common dynamometer for load measurement. The lower ends of the straining screws are connected to the wing specimen through a series of " Christmas Tree " loading beams to apply vertical loads to it.

In the landing case test, only the two innermost straining units were used, one on each wing, to provide all vertical loads required. These included main undercarriage reactions, inner and outer engine inertias and an additional vertical up-load to the rear spar to produce the correct rear spar shears in the critical region. A separate hydraulic rig applied main undercarriage drag and side loads.

When the specimen was tested under these landing case loads, certain modifications to the fuselage became necessary, due to the fact that the fuselage loads were too high and not representative. Minor modifications were also necessary to the nacelle structure. After these had been incorporated, the specimen was satisfactorily loaded to proof and none of the wing structure showed any appreciable permanent deformation on removal of these loads.

All six straining units were used for the gust case tests to apply distributed uploads to the whole of the wingspan, representing lift-minus-inertia loads. In addition, certain downloads were applied by a separate hydraulic system to produce the correct torque on the wing. Pres-

surisation of the fuselage to its working pressure of 8·3 lb per square inch was necessary to obtain the correct front and rear spar frame conditions.

The specimen was tested to failure. Examined at 95 per cent of the ultimate design loads it appeared perfectly satisfactory, but failed at 98 per cent of these loads. Bristol and R.A.E. personnel concluded that the primary site of failure was in the front spar outboard of the outer nacelle in the starboard wing. Relatively small modifications there will bring the strength of the wing to over 100 per cent. The rest of the damage was agreed to be secondary and to have been precipitated by one of the few weaknesses of the "fixed deflection" type of rig—the way in which the deflected shape of the wing is held by the mechanical straining units.

Three stages in deflection of the "Britannia's" starboard wing under test (Gust Case—Ultimate Test) are recorded by separate exposures in our illustration. The stages shown, in ascending order, are: zero; proof load; 97·5 per cent.

Wing Thermal Anti-Icing System

The flow pattern of gas distribution to meet anti-icing needs along the wing loading edge will be finally tested in flight, but to adjust the flow regulators approximately the equivalent flow pattern for cold air has been checked on a ground check rig, illustrated herewith.

To reproduce ram air conditions, cold air was blown into the main connecting ducts by a centrifugal fan to reproduce ram air conditions. Air distribution was corrected by the air flow regulators at the exits from the chordwise corrugations of the leading edge, so as to give the correct distribution for the four-engined flight condition.

Three-engine conditions were also reproduced to check the alteration in flow with either the inboard or the outboard engine inoperative. No material change in the flow pattern was noticeable.

These tests were carried out on only a portion of the system and are being extended to cover the full half-span leading edge complete with all wing air intakes before actual flight measurements.

The Functional Mock-up—Undercarriages

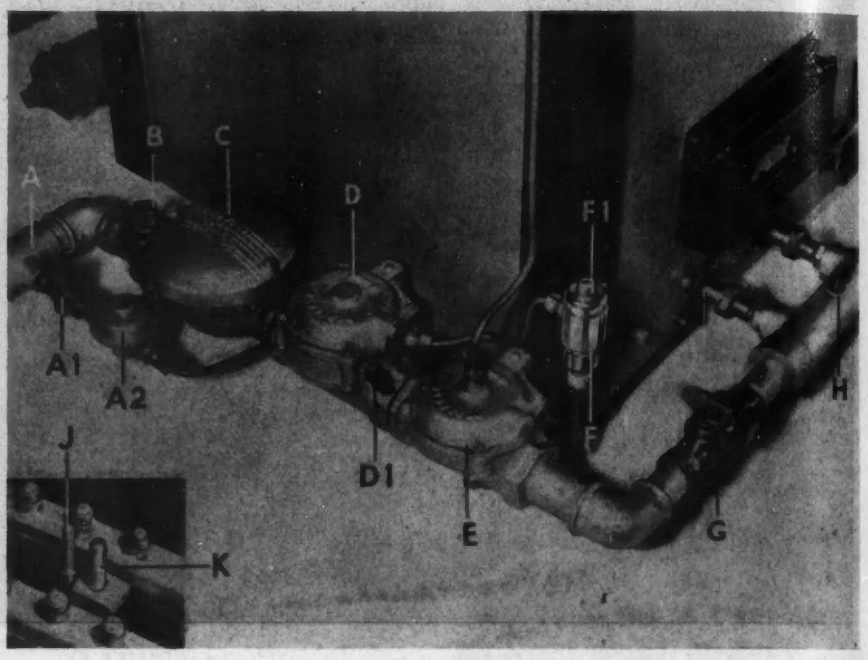
Work is proceeding steadily on the Functional Mock-up, aptly known as the "Non-Flying Prototype." Nose and main undercarriages have been fitted and retraction tests have begun. Part of the test schedule calls for an endurance run of 1000 cycles, to check the operation of cut-out valves, warning lights, pressure gauges, control valves and switches, and to gauge the wear on rubber rings and seals in jacks, accumulators and swivel joints.

During these tests and at regular intervals the undercarriages are being lowered by means of the emergency systems:—(*a*) electric motor pump unit and (*b*) by hand pump.

At each lowering, the hydraulically-operated brakes are applied to check the hydraulic circuit and mechanism.

Combined Flame Failure and Gas Pressure Cut-off Device

WE saw demonstrated on Wednesday of last week a control combining the operation of a pressure cut-off valve and a flame failure device which has now been under development for the last two years by the Gas Group of Thomas De la Rue and Co., Ltd., for use on its "Rex" series of "Potterton" gas-fired boilers. The system appears to function simply and effectively for all the circumstances leading to the common shortcomings of control systems, whether due to mechanical fault or human fallibility.



Arrangement of Control Units

Operation

The "Perfecta" control system consists of a permanent pilot, thermo-couple unit and a thermo-electric valve operating a reversed action relay valve, which is weep reset. Our illustrations show the general details of the control system, as installed and a diagrammatical working drawing.

Lighting.—The burner cock *G* is first closed, this being a first requirement of the lighting technique. It prevents relief of the gas pressure through the valve stem *U*. On lighting the pilot jet an E.M.F. is generated in the thermo-couple *J*, which energises the magnet *L*. The button *F* is then momentarily depressed by hand, bringing plate *V* into contact with the magnet. This action forces the valve on to its seating *N* and closes the relief line *R*. By depressing the reset button *D*, for ten seconds, gas enters through the valve *W* and develops a pressure under the diaphragm *P*, raising the valve *S* from its seating *T*. The burners are then ignited by the pilot on opening the burner cock.

Flame Failure.—In the event of flame failure the thermo-couple cools and de-energises the magnet. The valve is then thrust off its seating *N* by the spring *M* and gas is released through the vents *O*. The pressure under diaphragm *P* is thus relieved through the relief line *R* and valve *S* falls on seating *T*, so cutting off the gas supply, an operation taking in all about thirty seconds.

Pressure Failure.—If pressure in the gas supply falls below 1in w.g., pressure is relieved under diaphragm *P* through the valve stem *U*, and valve *S* again falls on its seating. This operation is almost instantaneous.

This new control is hence claimed to overcome the four major shortcomings which have been found to exist in the flame failure devices most commonly used on "Rex" boilers. These are stated as follows:—

(1) Leakage of gas in the relief line from the control valve causes the valve to fail to danger, i.e. with the gas left on to the main burner. This leakage can occur through a loose union or through a fracture of the small-bore copper pipework.

(2) Blockage of the orifice in the control valve also causes the valve to fail to danger.

(3) Explosions caused by brief and ill-considered shut-off of the gas supply, or use of the incorrect lighting sequence.

(4) Failure of the thermostatic element of the flame failure device may cause the valve to fail to danger.

The design of the new system aims to obviate these disadvantages in the following manner.

(1) Leakage of gas on the relief line causes the valve to fail to safe as gas pressure cannot be maintained beneath the diaphragm.

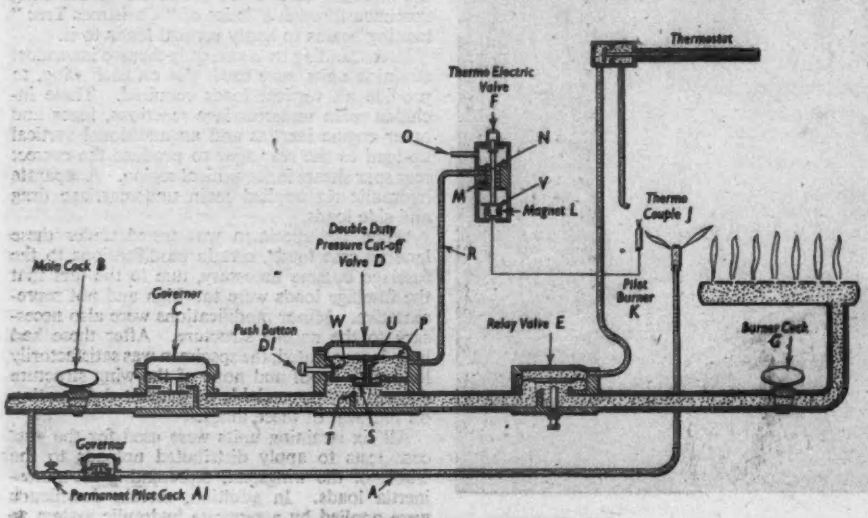


Diagram of Control System of Gas-Fired Boiler

(2) Small orifices which might become blocked are eliminated.

(3) If there is any interference with the main gas supply or if, for any reason, the pressure in the gas main drops below 1in w.g., the valve shuts off and gas cannot be brought on again unless the controls are correctly reset by hand.

(4) Failure of the thermo-electric device causes the valve to close, shutting off all gas.

The control ensures that the operator must go through the full predetermined lighting sequence before the boiler can be brought into operation : at the same time, if there is any failure of the operative parts, or leaks in the small-bore pipe connections, then it fails in the safe position.

Components *F*, *J* and *K* are duplicated in parallel for each additional pair of burners, so that failure of any one of these sets will close the double-duty device.

Failure Operation.—The double-duty device will therefore shut off gas if the main gas cock *B* is momentarily turned off, or if the gas pressure drops below 1in w.g. ; if there is a leak on the weep line connecting valve *D* to the thermo-electric valve *F*, and if the pilot flame is extinguished, or if, for some reason, there is failure to supply E.M.F. from the thermo-couple *J*.

Before gas can be re-established to the main burners the burner cock *G* must be turned off and the correct lighting procedure repeated.

High Voltage Test Laboratory

THE expanding demands for the company's products and the increasing voltages used in electric power transmission have caused the Brush Electrical Engineering Company, Ltd., to extend its transformer test facilities with the intention of testing not only for 132kV working but also for the 275kV value established for the "super grid." At a later date it is hoped to extend the investigations to the 400kV range. For the purpose of carrying out the testing programme, the Brush Electrical Engineering Company, Ltd., has built a new high-voltage test laboratory at Loughborough, which was officially opened by Sir Ben Lockspeiser, K.C.B., F.R.S., on Tuesday of last week.

In his speech at the opening ceremony, Sir Ben said that the construction of such a laboratory was evidence that the company was determined to keep abreast of scientific advance. It was not an easy task, for since the turn of the century developments had been rapid and signs were not lacking that the pace of technical progress would increase. Continuing, he affirmed that it was essential for our industrial economy that a good proportion of any developments should originate in this country. Developments in other branches of science, such as electron microscopy, had stemmed from the study of insulation strength problems and Sir Ben hoped that the laboratory would not confine its work only to tests. In declaring the laboratory open Sir Ben Lockspeiser stated that the installation was entirely the design of the Brush Company's staff, who had made full use of the resources of the high voltage laboratory of the National Physical Laboratory and of the British Electrical and Allied Industries Research Association.

Building and Equipment

The purpose of the new laboratory is to test completed transformers as part of both investigation and acceptance tests and to carry out investigations on insulating materials and assemblies of insulating materials. An extension 80ft long by 40ft wide by 40ft high of an existing building forms the laboratory to house the test equipment. The large transformers are transported to the laboratory by a rail track, which runs for the width of the building at one end and passes through roller shutter doors, which give access to the production bay and the off-loading area. At the opposite end of the building is the administrative block, housing a 50c/s control room, an impulse generator control room and a records room on the first floor, and an office, a conference room and a dark room on the second floor, at which level there is an observation gallery.

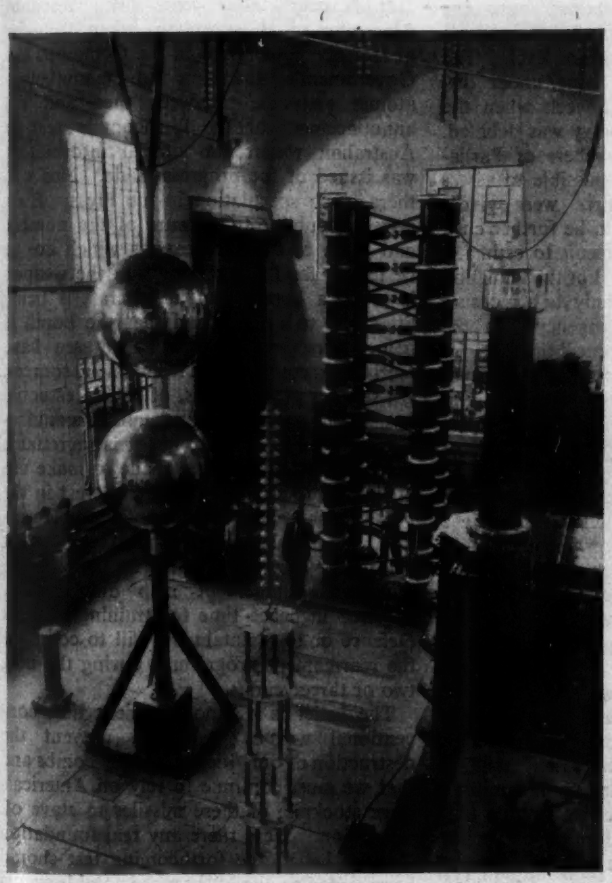
There is a twelve-stage impulse generator, each stage consisting of two 0·12 μF condensers connected in parallel. Supplied from a Cockroft-Walton voltage doubler circuit the charging voltage per stage is 125kV, so that the total output voltage with the stages connected in series is 1500kV and the stored energy at peak voltage is 22·5kW-seconds. The stages can be connected in various groups of series parallel arrangements and the mechanically coupled main tripping gaps are driven through eccentric cams by a remotely controlled geared motor, while the gap setting is indicated on the main impulse generator control board. The auxiliary tripping circuit is a Miller needle gap, with variable switched time delay in the pulse circuit to the needle gap, giving an overall delay range of 0·5 to 25 micro-seconds.

Voltage recording is by a matched resistance-capacitance voltage divider, of which the low voltage arm is wired back to the main impulse generator control board, and a 150cm sphere gap assembly measures the voltage, the insulated sphere being fixed and suspended from the roof girders by three insulated rods terminating in a stress cone just above the sphere. A gear motor unit drives the movable earth sphere through a range up to 0·75 diameter at about 90cm, and the gap is recorded remotely on two indicators on the control board, one covering the range 0 to 120cm and the other 0 to 10cm.

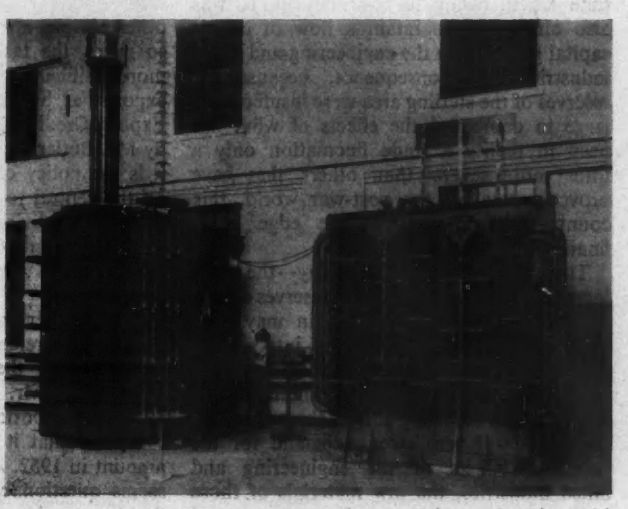
High voltage at power frequency is obtained from a 2000kVA, 3·3/500kV oil-immersed, double-wound Brush transformer, a 2000kVA test alternator outside the building supplying the 3·3kV winding. The high-voltage winding has a cascade winding at the high voltage wound for 3·3kV to enable a future extension up to 1000kV.

An aluminium tubular busbar system mounted on glass string insulators, suspended from the roof by small hand winches, interconnects the laboratory equipment. The main control panel is sited in the impulse generator room and houses all the indicating circuits, master switches, polarity changeover switch control, voltage regulating circuit for the main supply transformer to the generator, sphere gap control and gap indication, and also the recording equipment, consisting of four high-speed oscillographs built to an N.P.L. circuit. Each oscillograph includes a single 10kV cathode-ray tube and a camera with a f/1·5 lens for recording on 35mm film with sweep speeds from 0·5 to 250 micro-seconds. Each recorder is mounted in a portable rack.

As a safety measure, "make-dead" and "make-alive" buttons are duplicated in each section of the control panel and there is a "make-dead" switch on the observation gallery, while all main doors into the laboratory are electrically interlocked so that when opened the impulse generator is earthed.



Impulse Generator



Flash Testing Transformer

THE ENGINEER

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ECONOMICS AND ARMAMENTS

When the rearmament policy was adopted by the Labour Government, some two years ago, it was supposed, with some optimism, that the rate of industrial production in this country would continue to increase at much the same rate at which it had been increasing since the war. It was true that the programme called for an expenditure upon arms that would absorb more than the additional increment of output that it seemed reasonable to expect. Yet, by making small and temporary economies in capital expenditure and in other ways, it was possible to hope that the armaments could be produced without seriously affecting the oversea balance of trade. In fact, however, there corresponded with the decision to re-arm one of those fluctuations in trade that have repeatedly, since the war, created a financial crisis for the sterling area. Owing to shortages of raw material total production in this country ceased to rise, and abroad it became more difficult to sell consumer goods just at the time when, owing to re-armament, it was also difficult to maintain a flow of export capital goods from the engineering and allied industries. In consequence, because the reserves of the sterling area were insufficiently large to damp out the effects of what has been in reality a trade fluctuation only a little more severe than others that have proved normal in the post-war world, this country was brought to the edge of a financial disaster.

There are plenty of signs to-day—the slight increase in the gold and dollar reserves during July is one of them—that Britain may now be running, at least temporarily, into a more favourable trading period. It is true that the consumer goods industries are finding export markets still difficult. But there remains abroad a still very strong demand for the capital products of the engineering and allied industries, the raw materials of those industries have become less scarce, and larger supplies of steel are likely very soon to become available. There is, in fact, plenty of indication that the output and the exports of the group should soon rise. The beneficial effects upon the balance of trade must be marked. The Government, however, is not content to let matters rest there until, through some new fluctuation in the flow of trade, another financial crisis hits the sterling area. It has long since recognised that the gold and dollar reserves of the sterling area are too low stably to finance its trade. It is therefore continuing to take measures intended to build up those reserves to a more adequate level. The latest of these measures came under discussion in Parliament last week when the economic state of this country was debated. But, unfortunately, as Members of Parliament found, it is scarcely possible to assess their effect, so few figures were given. Imports, for instance, are to be further cut; but by how much it is difficult to estimate. It is to be hoped very little. For the reduction of imports is satisfactory only as a measure to meet a short-term emergency. In the longer run it can only "export" the financial difficulty it is designed to relieve, cause other nations also to "slash" imports, and so make the task of the British exporter more difficult. The encouragement of exports, as by giving further aid under the Export Credits Guarantee Act, announced by Mr. Butler, is a better policy. And, since it is the policy of the Government to build up the central reserves of the whole sterling area, it is obviously good policy to hold in the autumn a Commonwealth Conference so that all its nations can thereafter act in concert.

Two further measures announced in the debate need reference here, since they must affect directly the work of the engineering industries. Mr. Butler remarked that in 1951 coal exports amounted to 7·8 million tons, and that it was hoped to double that amount in 1952. The wisdom of that policy seems questionable. It is true that in the first twenty-nine weeks of this year 2·2 million more tons of coal have been produced than last year; it is true also that distributed stocks of coal are now nearly 4 million tons higher than they were twelve months ago. But coal output has in recent months been more than adequate to meet demand only because the winter was mild, and because industrial output having been checked by shortage of raw materials, industrial demand was unexpectedly low. Like the gold and dollar reserves, coal stocks in this country since the war have never been high enough securely to absorb fluctuations in supply and demand. Rather than export the welcome but probably temporary excess output of coal would it not be better to build up home stocks to a really satisfactory level? Last, but by no means least, it was announced that substantial quantities of arms are to be exported. To engineers it will seem a sensible decision. For the cost of tooling up for the production of armaments is high, and capacity has had to be provided to produce armaments at the high rate necessitated by the desire to rearm quickly. Once, however, the Forces have been rearmed the mass production capacity created will be excessive for the mere maintenance of the armed Forces. Why should we not profit by that excess capacity by exporting a proportion of its output to the "friends and allies throughout the Commonwealth and N.A.T.O." to whom Mr. Churchill referred? Even though that policy may delay for a while the full equipment of our own Forces it will help to keep in being and in an efficient state plants that would prove of immense value were war actually to break out.

THE ATOMIC WEAPON

It is nearly four years since Viscount Alexander of Hillsborough, when Minister of Defence, announced in the Commons the Government's intention to manufacture atomic weapons. Between then and the announcement of the forthcoming test in Australian waters, no official information was issued of the progress made. Nor was there much speculation in the Press. Even now the public are unaware of the number and types of atomic weapons which are to be tested, for Press reports that the weapon is to be a bomb, that an aircraft is being fitted out to drop it and that the bomb is being conveyed to Australia by sea have received no confirmation from official sources. On security grounds it is, of course, essential to maintain secrecy on the details of manufacture of the new missile, but it is regrettable that no attempt has been made to make use of the test to stimulate public interest in the possibilities—and limitations—of atomic warfare. Until they are generally recognised it will not be easy either to recruit the essential minimum number of men and women required in peace time for training in Civil Defence or to maintain the will to complete the rearmament programme during the next two or three years.

The belief is all too prevalent that conventional weapons will not prevent the destruction of our cities by atomic bombs and that we must continue to rely on America's large stockpile of these missiles to stave off aggression. Were there any real foundation for this belief, the forthcoming test should be regarded as one of the more notable events in British history, for this country would

not long remain a Great Power if we were to rely for our safety on another nation. Moreover, it is by no means certain that the United States will always be willing to come to the assistance of the free nations of Europe. In fact, as is evident from the war in Korea, the prospect of a hail of atomic bombs does not prevent aggression. China—and thus also Russia, because of her Treaty commitments—could not have been sure that these missiles would not be used against her. None the less, Peking went ahead with its plans. We are, indeed, faced with a missile of vastly more destructive power than those hitherto used, but the counter to it is far from ineffective, if there is the will and determination to defend ourselves. This necessitates our having an adequate number of interceptor and fighter aircraft, radar stations, anti-aircraft guided missiles and guns, and a large number of fast anti-submarine vessels and aircraft patrols to locate and deal with the guided missile firing submarine. Last, but by no means least, much can be done to minimise the effects of the explosion of the atomic missiles which might reach this country, by assisting in Civil Defence and taking proper precautions. It is frequently forgotten that the radio-activity generated by the air burst over Hiroshima accounted for only about 15 per cent of the casualties ; 50 per cent were caused by blast—in the same way as casualties were caused by the bombings on Britain and Europe, only on a much larger scale—and the remainder were due to burns, either from the fires resulting from the explosion or from the intense heat generated by it. Many thousands died because they did not bother to take cover when the alert sounded and many others bled to death or died from other medical causes because they did not receive first-aid treatment in time.

It is also possible that, just as the Germans did not use poison gas in World War II through fear of the Allies using a more effective gas against them, Russia will refrain from using atomic weapons against the civil population—a possibility which seems the more likely after the recent atom tests in Nevada. In these tests the atomic explosive was successfully used in a more limited sphere—for tactical purposes against troops in the field. The missile employed was a small bomb, but it might well have been some other form of missile. For, according to official information from the United States, atomic explosive can now be used for conventional weapons. Indeed, two years ago the bomb had been sufficiently reduced in bulk to make practicable its employment by medium-sized (carrier-borne) aircraft. This can only mean that the original heavy and cumbersome gear for bringing together two pieces of fissile material just under the critical size has been replaced by some other method of detonation—possibly by energising the material through the detonation of other explosive surrounding it. The tests at Nevada have, in any event, dispelled the widespread belief that residual radio-activity would kill all living matter in the immediate area of the explosion. Troops marched through the blast zone soon after the detonation of the bomb without suffering any harmful effects. Tanks, planes, jeeps, guns and other equipment were placed near the area where the bomb was to be exploded, and live sheep were tied to sheltered positions which would normally be occupied by troops under actual battlefield conditions. Subsequent examination showed that buildings in the area would have been demolished, but vehicles and other equipment gave evidence only of the effects of burns and other minor damage. Above ground no human being in the area could have survived, but below ground, or in pill boxes, the sheep were alive and unharmed. Troops in similar positions would have been safe. The tests, indeed, proved that the atomic bomb can be highly effective as a tactical weapon, but that the value of the infantry soldier has not changed. Properly trained and protected he can survive an atomic blast and still carry on to achieve his objective. The atomic missile is in fact no more likely to be decisive than the war elephant, gunpowder or the torpedo boat, which were all in their day hailed as a decisive weapon. It is no more than an additional danger to be dealt with in modern war. Forces of all arms are required not only to win a war but to prevent one, and there is no alternative for the free nations but to tread the hard road and persevere with rearmament.

Obituary

SIR WILLIAM GRIFFITHS, D.Sc.

We record with regret the death of Sir William Thomas Griffiths, which occurred on Wednesday, July 30th, at Redhill County Hospital, Surrey, after a brief illness. Sir William, who was fifty-seven, was, until recently, chairman and managing director

Sir William Griffiths

of the Mond Nickel Company, Ltd., and a vice-president of the International Company of Canada, Ltd.

Sir William was born at Cardiff in 1895, where he was educated at the Howard Garden School, and subsequently at University College, Cardiff. After service with the Royal Engineers in the first world war, Sir William was appointed to the metallurgical staff of the research department at Woolwich Arsenal where he remained until 1926. In that year he began his association with the Mond Nickel Company, Ltd., by becoming manager of the research and development department. Sir William occupied that position for the next nineteen years or so, and in 1945 he was appointed chairman and managing director of the company. At the same time, he was elected a vice-president of the International Nickel Company of Canada, Ltd. He retired from both offices about eighteen months ago.

For many years, Sir William had been a member—and subsequently a Fellow—of the Institute of Metals. He was elected president of the Institute in 1944, in which office he served for a term of two years. Those years were difficult ones for the Institute, and the progress of its work during the closing months of the second world war and the early part of the post-war period was greatly assisted by the wise guidance which Sir William readily gave as president. Upon taking office, he recalled that the Institute of Metals was already international in its membership, and he expressed the hope that it would not be solely national in its outlook. During his presidency, the National Certificate in Metallurgy was established, the Institute of Metals taking a leading part in formulating the scheme. Sir William was also a Fellow of the Royal Institute of Chemistry and a Fellow of the Institute of Physics. In addition, he had served on the councils of the British Non-Ferrous Metals Research Association, the British Cast Iron Research Association, and the Federation of British Industries, and on the advisory council of the Department of Scientific and Industrial Research. Sir William received his knighthood in 1946.

Literature

A Textbook of Mechanics. By J. G. Jagger. London : Blackie and Sons, Ltd., 16/18, William IV Street, Charing Cross, W.C.2. Price, four parts in one volume, 60s.

This textbook sets out to "cover all the ground the average engineering student is likely to need in his study of statics, dynamics, theory of machines, elasticity, vibrations, hydrostatics and hydraulics." This is certainly a very tall order, but the author has written nearly 860 pages in pursuit of his aim, and has succeeded in covering a remarkable amount of ground, even though the individual subjects are not taken to the advanced stage which the author's preface might lead the reader to expect. There is nothing particularly new to be found in this textbook : the treatment follows the well-worn channels of the standard engineering course in a technical school, and the arrangement and presentation has a familiar stamp. Within this framework, however, it is very well written : it is clear and concise and the student who has to work very largely on his own should find it reliable and helpful. It can be bought either as one comprehensive volume or as four separate textbooks, each treating a division of the work.

Part I of the book deals with the Principles of Statics, covering the statics of particles and rigid bodies. This is followed by consideration of framed structures where the usual methods of analysis are given, although no reference is made to the method of tension coefficients which has advantages in some cases. The second Part is on the principles of Kinematics in relation to simple links and elements. The construction of velocity and acceleration diagrams is described and examples of constrained motion and connected bodies are given. The next Part is devoted to the subject of Dynamics, and

is a clear, elementary treatment, using the minimum of mathematics. The division of the subject matter necessitates a certain amount of duplication (for example, the sections on Vibrations in Part III are of necessity largely duplicated later in Part XI on Elastic Vibrations.) A useful summary of the properties of plane areas and solid bodies appears as Part IV, and forms an introduction to Part V, which treats the motion of solid bodies.

Parts VI and VII contain the more important applications of the work of the earlier sections and cover the ground usually called "Theory of Machines." The subject headings in fact are unusual for a book of this nature, the next part being headed "Elastic Bodies," although it is an elementary treatment of what has for so many years gone under the name of "Strength of Materials." The new title does not, however, herald a new approach, the treatment being the usual one, starting with simple stresses, the bending of beams, then going on to combined stresses, with practical examples in combined bending and torsion. This section is a little disappointing; the author claims, in his preface, a fundamental approach throughout, but a new viewpoint is overdue in this subject if real progress is to be made in the application of stress and strain analysis to the complex problems facing the engineer at the present time. The section on elastic vibrations is a compact statement of the ground work and the book is completed with two parts, entitled, respectively, Hydrostatics and Hydraulics.

The final chapter is on the theory of dimensions. This chapter might have been advantageously separated from the section on Hydraulics, since the student who has no previous knowledge of dimensional analysis may not appreciate that it has general application.

The book will undoubtedly be popular with engineering students. For those preparing for the Higher National Certificate or the examinations of the professional institutions it provides in one volume a concise account of nearly everything that is required within the subjects treated. It comes from an experienced lecturer who has also the rare ability of being able to express himself clearly on paper.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE FUTURE DEMAND FOR COAL

SIR,—I would like to assure Mr. Murland that in my letter (your issue of July 25th) I was merely quoting the phraseology of the previous correspondence and that I entirely agree that something less than perfect heat balance would show economies.

R. E. GAMLEN

Brighton, August 1st.

SIR,—I would make the following points in reply to Mr. Gamlen's letter (July 25th, issue) although much of the ground has been covered already by the publication, at the same time, of Mr. G. K. Alston's address, "Plan for Electricity," as well as in Mr. Murland's letter (August 1st). Both in the latter, and in Mr. Alston's address to the North Lancashire Sub-Centre of the Institution of Electrical Engineers, a strong case is made for the extended use of combined power and heating plants, i.e. back-pressure working, a matter to which I referred at some length in my letter in your July 11th issue.

I concede that an "increased efficiency in electricity production" may be expected, but if, in 1960, the B.E.A. still throws away 74 per cent of the heat in the coal delivered to its power stations, there will be no room at all for complacency. This will not be making the best use of our coal resources, or helping the coal export trade. As by far the greater part of the heat losses are through cooling towers or incurred in warming up rivers, the alternative system, which avoids the dissipation of latent heat in condensers, should be encouraged by every possible means.

There are some thousands of combined power and heating installations in this country, and many more thousands scattered over the rest of the world. All British land turbine and engine builders have manufactured them, and the majority of these firms advertise them to-day in the technical press. The extension of their use at the present time is hindered by the fact that the great majority of businesses find it impossible to plough back an adequate proportion of so-called profit with which to maintain real capital. Price and profit limitation, as well as excessively high-level taxation, are all factors contributing to this state of affairs. Another hindrance has been the attitude of the electricity supply industry in relation to standby charges.

Mr. Murland makes some important comments on Mr. Gamlen's words: "... and there is a perfect balance between heat and power requirements." To the factors which he enumerates for consideration when designing schemes of this kind, I would add vacuum refrigeration. This system can provide a practical solution to the problem of making use, in warm weather, of back-pressure steam which is used in winter for space heating. With this system a "steam-jet" refrigerator takes the place of an electrically operated vapour-compression unit.

If a factory requires process steam for 100 hours per week, and there is a perfect balance between heating and power requirements, then a cast iron case exists for back-pressure working. To emphasise this point, I quote the case of a small laundry in the Midlands in which an engine of only 15 b.h.p. is used. It operates for about fifty hours per week over five and a half days, and the overall thermal efficiency of the plant is 70 per cent.

Mr. Gamlen refers to the production of gas from low-grade coal, and his information would appear to be out of date. Cases have been reported in which gasworks carbonising low-grade fuels are operating at 60 per cent efficiency. Moreover, it is possible for the gas industry to use weakly caking coals and to manufacture by complete gasification. It has been proved that it would be more economic to gasify the coal at a colliery 100 miles from London and then pipe the gas, rather than transport the coal by rail. In the case of London, however, it should be pointed out that sea freight charges are comparatively low.

JOHN FOX,
M.I.Mech.E., Associate I.E.E., F.Inst.F.

Hove,
August 2nd.

SIR,—Mr. Murland, in your August 1st issue, is certainly correct in saying that lack of balance of power and heating loads is now no obstacle to back-pressure generation, but I think we must look beyond technical grounds for the answer to Mr. Gamlen's final question.

Back-pressure generation is in general use by the large progressive firms who employ competent engineers, but the position among the smaller concerns is usually different; the cost of heat and power generally represents a very small proportion of the selling cost of their product, so that little attention is paid to economy in these items. Yet in the aggregate these small factories waste prodigious quantities of fuel, which if saved would be quite sufficient to set our coal export trade on a healthy footing.

The first link in the fuel-wasting chain is usually the ignorance of the type of engineer employed in small process factories; it is common to find that the "engineer" has risen from the firing floor with length of service (sometimes called "experience") as his only qualification. However willing the managers of the firm may be to save fuel, they cannot start without a properly reasoned engineer's report, and if their engineer cannot produce it they are hardly likely to seek the information elsewhere.

I can quote two works engineers who told me with glee that their troubles were over—their (back-pressure) engines had broken down finally and they had "gone on the grid."

The Ministry of Fuel and Power surveys can answer the technical side of the problem, but the real crux—the human side—remains unsolved. I hardly dare suggest compulsory plant surveys and a coal and power ration based not on the factory's usage, but on its needs.

W. MELVILLE

Manchester, August 2nd.

FOREIGN WORDS IN BRITISH PATENT SPECIFICATIONS

SIR,—Would you please draw attention to the fact that foreign words are being permitted in British Patent Specifications, and there have been several instances in recent years? In a very recent case the words "*inter alia*" occur, whereas it would have been much simpler to have put "amongst other things."

Applicants and patent agents would be well advised to steer clear of this practice—and, of course, it is the final responsibility of the Comptroller of the Patent Office, who, I suggest, should not permit such words.

Do please urge that only British words be used in British Specifications.

"CLARITY"

Inverness, July 31st.

A Toothless Sawing Method

A METHOD method of sawing stainless steel and other high-alloy sheets, using blades of ordinary mild steel box strapping without teeth, has been developed by the Solar Aircraft Company, of San Diego, California. The new toothless sawing process is expected to reduce industrial accidents, to reduce costs and to save scarce strategic metals in the making of saw blades. According to the company, ordinary bandsaw blades costing more than 3 dollars each normally lasted less than two hours. Ordinary 0·035in thick mild steel box strapping, which costs only about 10 cents per band saw blade length, has lasted as long as twenty-nine hours of actual sawing. Furthermore 0·032in thick toothless spring steel blades, which cost slightly over 50 cents, were used for more than seventy hours. So far only preliminary studies have been made of the new technique, and it is not yet known how extensive its results will be. However, the early tests have confirmed that the toothless blades can cut stainless steel and high-alloy steels and have satisfactorily cut tool bits, files and cobalt steel. They apparently work best at high speeds and so far have only been tested on bandsaws. The action of bandsawing at high speeds is generally believed to be due to the friction of the saw blade quickly heating, the metal being cut to the melting point and thus burning its way through. Ordinary saw blades have been equipped with teeth largely on the theory that the teeth acted as tiny oxygen scoops to bring oxygen to the metal being cut and to speed the burning action. Now it is thought that the toothless blades become hardened and roughened within the first few seconds of use to a point where they scoop oxygen as well as, or better than, blades equipped with teeth. One reason why conventional saw blades have shorter life is that they break easily at the points where the teeth have been cut and hence where stress is concentrated. The toothless blades eliminate this problem.

Natural and Artificial Sources for Gamma Radiography*

By B. N. CLACK

THE requirements of a source suitable for industrial gamma radiography have been listed on several previous occasions, and it will therefore only be necessary to give them briefly. They are :

(*a*) A sufficient half-life.
(*b*) Suitable gamma emission.
(*c*) Sufficiently high specific strength, i.e., activity per unit volume.
(*d*) Availability at a reasonable price.

The first part of this article will review briefly to what extent these have so far been achieved.

Taking first half-life, considerations of convenience and cost per day's use dictate a minimum half-life of several days or, better, several weeks. There is no upper limit, but, in the case of artificial radio-elements obtained by pile irradiation a reasonable specific activity will only be obtained in an acceptable time if the half-life is not too great. The cost of occupying pile space and the waiting period involved thus set an upper limit to half-life which, with present pile fluxes, might be regarded as ten years. With natural radio-elements and fission products no such limit need be imposed.

Gamma-Ray Energy

Requirements may for convenience be divided into four groups :

(1) Radiation more penetrating than that from radium, for radiographing steel 6in thick or more.

(2) Radiation similar in penetration to that from radium for radiographing steel 2in to 6in in thickness.

(3) Radiation of, say, 400–500 keV energy for radiographing, say, ½in to 2in of steel.

(4) Radiation of, say, 100 keV energy for radiographing light alloys, thin sections of steel, &c.

Some possible elements with half-lives and gamma-ray energies are given in Table I. It will be noted that the radiation is usually heterogeneous ; this may not matter if there

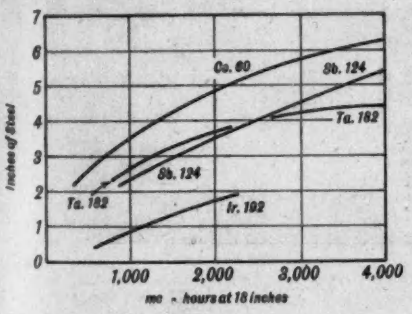


Fig. 1

are no strong components much harder than the main one or ones, but otherwise contrast will suffer. A mixture of fission products would also be unsuitable since the quality of radiation would change with time, often in an unpredictable manner.

Amongst sources in the first group there is little choice, perhaps only Na 24 and Sb 124. The former has such a short life (fifteen hours) as to rule it out. The second does, in fact, appear to give rather greater penetration than Ra as might be expected from the fact that some 35 per cent of its energy is present at 1·7 MeV. The technique curve for radiographing steel (Fig. 1) illustrates this point.† It is fair comment, however, to say that no suitable gamma emitter exists at the present to fill this need.

In the second group there are a good many choices. Ra, Rn, Co 60 and Ta 182 are already firmly established, the last being of particular value where the time of irradiation in the pile must be kept short. Other possibilities will be seen from the table (e.g., Eu 154, Sc 46), though present evidence does not suggest that they would offer any advantage over those materials already developed. Dutli and Tenney have compared Ra, Ta and Co sources using step-wedge penetrameters of various metals and find very comparable exposure times when the sources are compared on a rhm basis. Co, they find, offers some superiority in sensitivity and resolution, but it should be borne in mind that their Co source was some forty times greater than the Ra one in specific strength. Morrison, on the other hand, using a Co source of only some one-sixth of the specific strength of Dutli's records a lower sensitivity than with Ra, 2 per cent only being attained under favourable conditions. The size of the source is evidently of considerable importance in comparisons of this kind. Co has the advantage that corrections to exposure time for decay need only be made occasionally, say, every six months. Several technique charts have been published by workers in Canada and the U.S.A., that of Tenney giving the relative exposures for various sources with different metals being reproduced in Fig. 7, (p.197).

At the moment, there is no standard way of presenting data of this sort, some authors use the exposure factor $=\frac{mC \times mins}{(sfd)\,2}$, whilst others give an exposure in mC-hrs at a given distance. Again, some authors quote only for unity film density. With increased source strengths there is an increasing tendency to use higher film densities (up to four or five) to obtain improved contrast. Any technique chart to be complete should give information for film densities up to, say, five, and equally should give data for both normal speed non-screen type film and fine-grain, non-screen type film.

In the range of next lower penetration there are Ir 192, already established, and possible alternatives such as Sb 125. This is prepared from Sn 124 which by neutron capture gives Sn 125 from which Sb 125 is formed by β decay and chemical separation. It is also found as a fission product, but the yield is very low. A material with emission in the 100kV region does not seem easy to find. Nature has been fairly lavish in isotopes with radiation as penetrating as that from radium, or rather less penetrating, but both ends of the scale are much less well filled. One possibility is rubidium 87, a natural radio-element which occurs to some 27 per cent in Nature. Calculation shows, however, an impossibly small intrinsic strength due to the long half-life. Another possibility is Eu 155, obtained by the reaction Sm 154 (n, γ), Sm 155 with β decay to Eu 155, but the wanted material is masked by Sm 149.

TABLE I—*Possible Gamma Emitters with Half-Lives and Energies*

Element	Half-life	MeV gamma energy
Sodium 24	15 hours	1·4, 2·8
Antimony 124	60 days	0·12, 0·61, 0·65, 0·73, 1·7, 2·0
Radium	1590 years	0·6, 1·12, 1·76, &c.
Radon	3·82 days	0·6, 1·12, 1·76, &c.
Cobalt 60	5·3 years	1·1, 1·3
Europium 154	5 years	0·12, 0·34, 0·41, 1·2
Tantalum 182	120 days	0·15, 0·22, 1·13, 1·22
Scandium 46	85 days	0·88, 1·12
Iridium 192	70 days	0·30, 0·47, 0·60
Selenium 75	127 days	0·12, 0·14, 0·27, 0·4
Hafnium 181	46 days	0·52, 0·3
Osmium 185	95 days	0·75
Mercury 203	51·5 days	0·3
Antimony 125	2·7 years	0·55
Cerium 144 ... } Praseodymium 144 } ...	275 days	None 1·25, 0·22
Rubidium 87	10^{10} years	0·03, 0·05, 0·08, 0·10, 0·13
Europium 155	2–3 years	0·084
Cerium 141	28 days	0·14

Specific Activity

In the case of naturally occurring radio-elements, the properties of the material largely determine the specific strength, although the state of packing or chemical combination, if any, are also obviously important. With the fission products very high, specific strengths are at least theoretically obtainable, though the chemical separation involved may be difficult and costly. In the case of sources produced by pile irradiation, a high specific strength will best be obtained by using a material of high density and purity, preferably the pure element. This must have no stable isotopes in any appreciable amounts which will activate to unwanted energies.

Should the material be too reactive chemically, we must choose a compound which will not be decomposed by irradiation in the pile or in which the other elements present will not be activated to give radio-elements with unwanted gamma radiation.

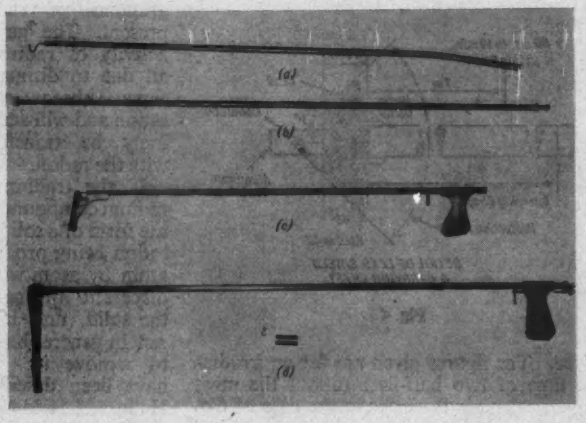


Fig. 2

* Based on a lecture to the Industrial Radiology Group, Institute of Physics. July 27, 1950.

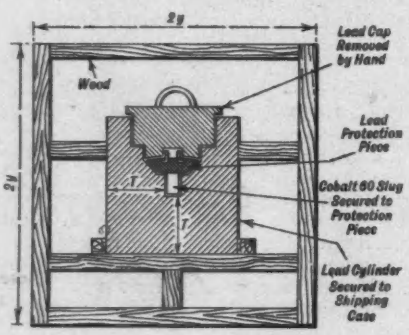
† I am indebted to Mr. W. S. Eastwood, of A.E.R.E., Harwell for Fig. 1 and most of the information in Table I.

If, as is often the case, the compound is in the form of a powder there will be a further reduction in specific strength due to the state of packing. The material itself must be relatively transparent to its own gamma radiation. We have already seen that high specific strength and long half-life are to some extent incompatible—there is one

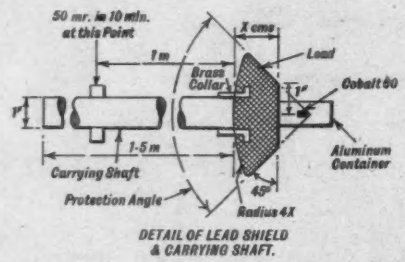
Fig. 3

further requirement: we must choose, if possible, a material of high capture cross section for neutrons.

It is interesting to compare the specific strengths available in this country with that of Ra, which, in the form of sulphate, gives us some 2 to 3mC per cubic millimetre, and is about the lower limit for an acceptable



ASSEMBLED LEAD CASTLE.



DETAIL OF LEAD SHIELD & CARRYING SHAFT.

Fig. 4

source. The figures given are for an irradiation time of two half-lives (about the most economical period) except in the case of Co, where this becomes rather long for practical purposes :

Ra	2 to 3 mC mm^3
Ir	97
Ta	7
Co	2 (1 year)
Ra	19,000

Dutli and Tenney indicate that at the pile fluxes available in the U.S.A. they are already able to obtain intrinsic strengths for Co some forty times that of Ra.

Containers

It would seem as though exposure containers need not differ much from those designed for radium, whose protection will in most cases be adequate since the radiation is no more penetrating. A general purpose container will have a port to be opened to expose a cone or disc of rays, whilst the source may be removed completely if required. Morrison has published some interesting designs (Figs. 2, 3, 4), in which the capsule may be removed by screwing into it or grabbing it between two trigger-controlled, spring-loaded jaws. In one design there is at the end of the carrying shaft a lead shield to screen a 45 deg. cone such that the dose at 1m is only 50 mR in ten minutes. On the whole, a plug-in type of capsule probably makes for more speedy handling. Experience also shows that some degree of mechanical strength is also needed to withstand the handling received, e.g., in foundries, heavy engineering shops, &c.

The second part of this article describes the preparation of a radiographic source using radon and attempts to show some of the problems met with in so doing. Several articles have dealt with the economics of Rn compared with Ra as a source, all concluding that the casual user should use radon, but the radiographer who needs a source more or less continuously should use radium. In practice, the superiority of radon as regards source size is the controlling factor, most of the demand for radon is a steady one and the user is prepared to tolerate the inconvenience involved in order to get a better quality of radiograph.

Radon is, of course, the first disintegration product of radium and it has a half-life of just under four days. If it is continuously removed from its parent radium it is formed at a constant rate, but if sealed up with the radium so that it cannot escape a state of equilibrium is rapidly formed so that after a period of some weeks the amount of radon present is sensibly constant, viz., 1 Curie, or about two-thirds of a cubic millimetre per gramme of radium present. The gamma activity of radium is all due to disintegrations subsequent to radon and will accordingly be transferred with the radon.

If the radium or radium compound is in the form of a solid, the radon being produced atom by atom will be dispersed throughout the solid, and it will not in general be easy to remove it. Various emanating solids have been described in the past, e.g., by Hahn and Heidenhain, but there is as yet no satisfactory large source of this type. If the radium compound is used in the fused state or in the form of an amalgam or a solution, most of the radon will be readily removable—an aqueous solution of the chloride or bromide is nearly always used in practice. The only disadvantage is that bombardment of the water produces electrolytic gas, some 50 cubic centimetres per gramme each day alongside 0·1 cubic millimetres or so of radon. Small amounts of ozone, bromine or chlorine and helium are also evolved. Purification depends on two facts ; first, that radon is inert chemically, and, secondly, that it has a high boiling point. Most methods rely on removing condensable gases other than radon either by chemical traps or by physical means, condensing the radon in a trap cooled by liquid oxygen and then pumping away the remaining gases, largely, O_2, H_2 and N_2. Many designs of apparatus have been published, and Fig. 6 shows the basis of a method, well suited to large radiographic sources, due to Dawson in which the condensable gases (H_2O, CO_2 derived from breakdown of tap-grease or organic impurities, HCl, Cl_2, or

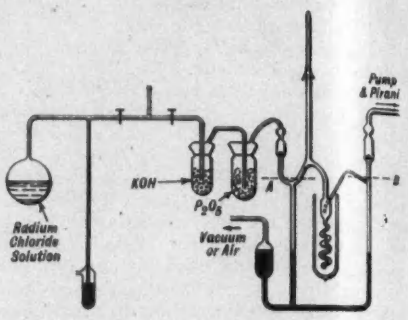


Fig. 6

HBr, Br_2) are removed by flowing the gas continuously over KOH and P_2O_5 traps. Any plant should be simple in concept and layout, as foolproof as possible, and should need little maintenance, e.g., chemical traps should last for reasonable periods and taps should be kept to a minimum. Greased

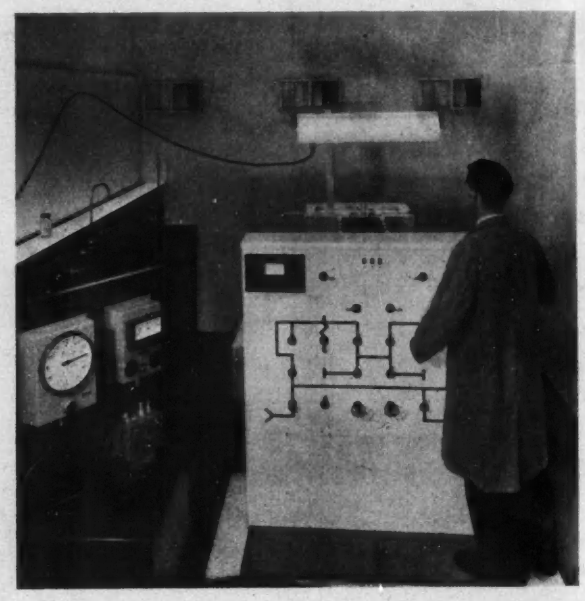


Fig. 5

stopcocks should be avoided if possible due to the rather short life of the grease. The mercury float valve described by Stock is useful, and Sutton has recently described a greaseless magnetically operated cut-off using a mercury seal. This suffers from rather complicated opening and closing operations, it being necessary to remove the sealing mercury first, and, in addition, two cut-offs in opposition must be used to withstand pressure in either direction. A really simple and effective cut-off not employing grease would be very welcome in this field.

To comply with modern standards of protection, purification must be carried out without the operator approaching the active part of the apparatus. This has been

tackled in two ways—either by making the apparatus largely automatic or by retaining manual operation and including a screening wall through which the controls pass. Fig. 5 shows an installation of the latter type, two of which are in use at the Radiochemical Centre, Amersham. The radium solution is housed

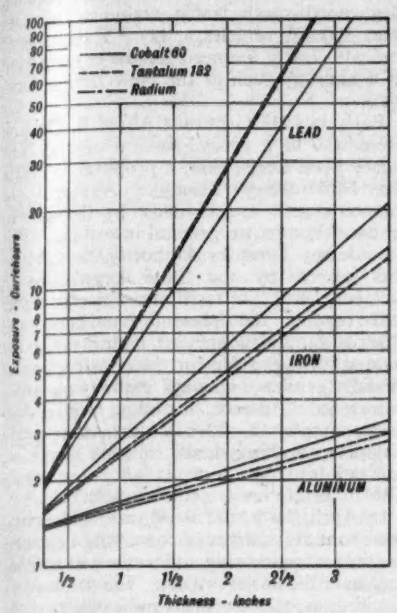


Fig. 7

in the 6in walled lead safe at the rear, a total of 9 grammes radium element being used in the two plants, and the operator is protected by a 2in lead wall behind the front panel. Float valves controlled by vacuum from the panel are used wherever possible, greased taps being only retained for the main taps to the source where the greatest reliability is essential. It is gratifying to report that, with these, regreasing is only necessary about once every year. In a typical case a 1000mC seed can be extracted, measured and packed without the dosage rate at the operator's position (which rate grows as the extraction proceeds) ever reaching 50 mR per eight hours. The total dose in extracting, measuring and packing

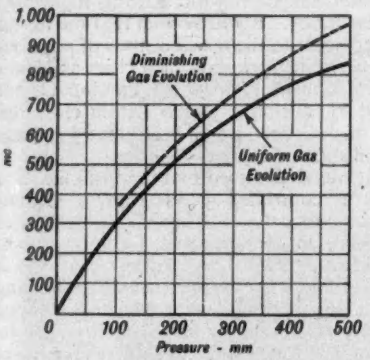


Fig. 8

is only some 5 mR on the body and 30 mR on the fingers. Ventilation, from the operator's end of the room, changes the air every two minutes, and no measurable contamination of the air is observed during an extraction. Any hazardous operations such as renewing the chemical traps are performed in a ventilated cabinet and, should any major maintenance of the plant likely to contaminate the atmosphere be necessary, the operators are provided with self-contained breathing outfits. In most plants a purity of 10 to 20 per cent is claimed. Impurities are due to :

(1) Condensable gases, not trapped by the chemical traps, which condense with the radon.

(2) Residual pressure in the system.

(3) Production of electrolytic gas due to decomposition of water in the condensation trap, which in the latter stages of the purification will not be pumped away.

(4) Condensable gases formed after the gas has passed through the chemical purification, e.g., from decomposition of organic material or by release from the walls.

In practice, since the impurities are found to be largely condensable, (1) and (4) are probably the most important.

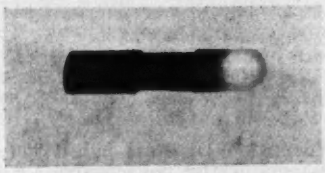


Fig. 9

An efficient condensation trap is by no means easy to obtain—it is not just a matter of passing the gas through a tube immersed in liquid oxygen; we have to ensure a collision with the wall at the very low concentrations involved and ensure that the molecule stays there once it has collided.

The distribution of radon between the solution and the atmosphere above it obeys Henry's Law ; at room temperature some 20 per cent will remain in solution from whence it may be removed by prolonged pumping. Allowing for some loss in the chemical traps the overall yield is usually 75 per cent of the theoretical growth. It is a matter of some importance to be able to estimate the amount of radon present. After the source has been pumped " dry," the growth of radon is, of course, exponential, whilst electrolytic gas is produced, to a first approximation, at a uniform rate. Our growth of radon with pressure will thus also be roughly exponential as in Fig. 8. However, as the pressure increases some recombination of electrolytic gas occurs and the

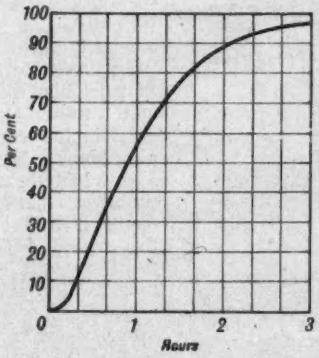


Fig. 10

rate of pressure rise decreases. This causes the observed curve of radon/pressure to be more linear than the theoretical curve. If a source is extracted completely, from its past history the amount of radon available can be computed, and allowing for the efficiency of the plant, it is usually possible to obtain an extraction within 10 per cent of the estimated value. If it is desired to extract only part of the radon present, the problem is more difficult since the mixture contains gases with molecular weights differing very considerably from one another. Thus the mixture drawn off will at first be too rich in hydrogen and finally too rich in radon. By using an empirical calibration for the plant it is, however, possible to estimate with sufficient accuracy the quantity of radon that will be obtained.

In the capsule into which the radon is finally sealed use is made of the high adsorption of activated charcoal for the gas.

As the molecular weight of the inert gases increases the adsorption of charcoal for the gas also increases, so that when Xenon is reached quite large quantities are retained

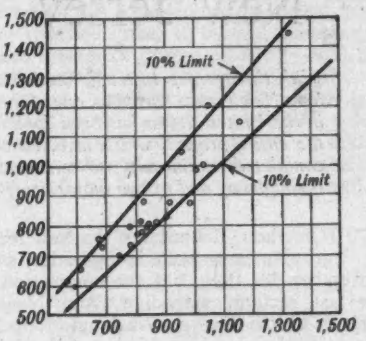


Fig. 11

at room temperature. For 1500 mC of Rn a tiny grain of charcoal no bigger than one-tenth cubic millimetre in volume is sufficient. Fig. 9 shows an autoradiograph illustrating the point source.

Radon when first extracted has no gamma activity. This arises from subsequent transitions. Consequently, the gamma-activity grows in the manner shown in Fig. 10. We make use of this fact by estimating the radon content from the gamma-activity during the first twenty minutes of the growth. Fig. 11 compares the radon content of a number of sources obtained in this way with that made from an observation after full growth, and it will be seen that the discrepancy is nowhere worse than 10 per cent. This is probably good enough for most radiological uses, and it is doubtful whether the increased exposure involved in measuring and fully grown source is justified. Usually the time of introduction of the radon—zero time—is well defined. If there is any doubt on this point it is evident from the fact that the extrapolated

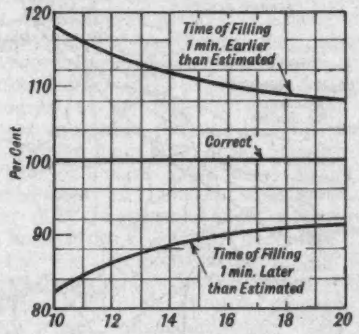


Fig. 12

value for radon content is not constant, but decreases or increases as shown in Fig. 12. It is pleasing to record that out of some 100 sources prepared, no complaint of the estimated radon content being in error has arisen.

The possibility of using other materials than glass for containing the radon is an attractive one. Several of the softer metals, if free from oxide, give a cold weld when brought into contact under sufficient pressure.

In this way every week many hundreds of tiny, yet robust, gold seeds are made containing radon for clinical use by dividing lengths of gold tubing on a blunt cutting machine. This both divides the gold and welds the end to give a vacuum-tight joint in one operation. This principle might be applied to radiographic sources containing radon or other radioactive gas and experimental sources have been made in this way from lead and aluminium tubing, which should be capable of withstanding far more severe handling than glass.

ACKNOWLEDGMENTS

The author is indebted to Mr. W. S. Eastwood, of A.E.R.E., Harwell, for Fig. 1 and most of the information in Table I. Figs. 2, 3, 4 are reproduced from a paper by K. J. Parry, of the National Research Council, Canada, and Fig. 7, also from a paper by G. H. Tenney, J. W. Dutli and J. E. Withrow. The photograph of Fig. 5 is reproduced by permission of the Central Office of Information. The author also wishes to express thanks to the Ministry of Supply for permission to publish this article.

New Jersey Turnpike, U.S.A.

No. I

With the opening to traffic on January 15th of the final 9 miles of the 118 miles long New Jersey Turnpike, one of the most important highway construction schemes in the United States has been completed. It is of particular interest to note that the entire project, which involved construction costs of 213,000,000 dollars, was completed within only two construction seasons. The design and construction of the highway and of two major bridge structures are described.

THE northern 109 miles of the New Jersey Turnpike have been in operation since November 30, 1951, but the completion of the last section, extending from Newark Airport to the George Washington bridge, was delayed on account of slow deliveries of the steelwork required for two major bridges. It is now possible for the motorist, at a toll charge of 1·75 dollars, to drive from the George Washington bridge, in New York City, south-west across the entire State of New Jersey to the Delaware Memorial Bridge, near Wilmington, Delaware, in just over two hours—about half the previous time for such a trip. It should be mentioned that the rapid progress of design and construction of the turnpike has been largely attributed to the excellent organisation of the scheme, employing various outside firms of consulting engineers rather than a large staff of engineers both to handle the design and construction of individual lengths of the highway and to co-ordinate the activities as a whole.

Geographically, New Jersey is one of the smaller states, but in terms of population and of importance to the economy of the country it is one of the greater states. As a result of its situation it has a concentration of traffic the like of which does not exist anywhere else in the United States, or perhaps anywhere else in the world. It is a corridor lying between the populous areas of New England and New York, Pennsylvania, the South and the West. In addition, it is the connecting route between New York and Philadelphia, the first and third largest cities in the country. New Jersey has not always had the traffic problem that confronts it to-day. In the period following the first world war it built the Pulaski Skyway, the Jersey City open cut, and a major part of the dual highway mileage in the entire United States. Then came the depression with its curtailed construction and after that, the second world war, with shortages of materials, money and labour. In 1946 it was estimated that New Jersey needed an expenditure of 600,000,000 dollars to bring its state highway system up to date and enable it to cope with the extraordinary traffic conditions which had arisen. Prior to the opening of the turnpike the traffic volume on U.S. Route No. 1, opposite Newark Airport, was in excess of 100,000 vehicles a day. In the narrow 9-mile corridor between the Orange Mountains and Newark Bay, north-south traffic amounts to more than 300,000 vehicles a day. These figures indicate clearly the need for the construction of a highway such as the New Jersey Turnpike.

Alignment of New Jersey Turpike

Early in 1948 Governor Alfred E. Driscoll presented, to a special session of the New Jersey State Legislature, a proposal to create the New Jersey Turnpike Authority to finance urgent trunk roads by the sale of revenue bonds to private investors. This New Jersey Turnpike Authority Act of 1948 was passed by the State Legislature in October, 1948, " to facilitate vehicular traffic and remove the present handicaps and hazards on the congested highways in the state, and to provide for the construction of modern express highways embodying every known safety device, including centre divisions, ample shoulder widths, long sight distances, multiple lanes in each direction, and grade separations at all intersections with other highways and railroads."

In April, 1949, the Authority sent invitations to various firms of consulting engineers to prepare engineering and traffic and revenue studies of the initial project. The preliminary conclusions of these firms indicated that the turnpike could be financed as a self-supporting project. Following the receipt of the engineers' preliminary reports, negotiations were begun immediately for the selection of consulting engineers of national repute for the final alignment of the highway; the preparation of contract plans and specifications; the drawing up of property maps; and the supervision of construction. The turnpike was divided into seven sections and eight firms of consulting engineers were selected to design and supervise the construction of the turnpike in accordance with Table II. These firms were given notice to proceed with their work in September, 1949.

Design of Turnpike

The accompanying map shows the final alignment of the turnpike and indicates the " interchanges " with existing highways in New Jersey. It will be seen that the turnpike is adjacent to the major centres of population in the state, including such cities as Newark, New Brunswick, Elizabeth, Trenton, Camden, and Philadelphia, and is within close reach of the densely populated areas of Bergen, Hudson, and Passaic counties.

It was determined that the turnpike should be a controlled-access express highway, which was defined as having all highway and railway grades separated, traffic in opposite directions divided by a safety mall, no left turns, specially designed traffic interchanges at reasonably long distances apart for entrance and exit of vehicles based on the right-turn principle, wide stabilised shoulders, moderate grades, and wide traffic lanes—all to be constructed on a wide right-of-way, with no

Table I—*Designed Standards of Turnpike*

Design speed, southerly 85 miles	75 m.p.h.
Design speed, northerly 33 miles (Except at Passaic and Hackensack River bridges, where 60 m.p.h. was used.)	70 m.p.h.
Maximum grade	3 per cent
Median width, including inner shoulders, southerly 85 miles	26ft
Median width, including inner shoulders, northerly 33 miles	20ft
Width of outer shoulders	16ft
Width of pavement lanes	12ft
Minimum radius of horizontal curves	3000ft
Vertical bridge clearance	15ft
Length of acceleration and deceleration lanes	1200ft
Width of turnpike right-of-way, southerly 85 miles	300ft
Width of turnpike right-of-way, northerly 33 miles	250ft

TABLE II—*Sections of New Jersey Turnpike*

Section	Location	Firm	Work	Length, miles
1	Deepwater to Woodbury	J. E. Greiner and Co.	Highway and bridges	20·2
2	Woodbury to N.J., Route 38	Gannett, Fleming, Corddry and Carpenter, Inc.	Highway and bridges	17·8
3	Route 38 to Hightstown	Parsons, Brinckerhoff, Hall and Macdonald	Highway and bridges	21·7
4	Hightstown to Raritan River	DeLeuw, Cather and Co.	Highway and bridges	24·5
5	Raritan River to Morse's Creek	Fay, Spofford and Thorndike	Highway and bridges	14·3
6	Morse's Creek to Bellville Turnpike	Ammann and Whitney	Bridges	10·5
7	Bellville Turnpike to Route 6	Howard, Needles, Tammen and Bergendoff	Bridges	8·6
6, 7	Morse's Creek to Route 6	Edwards and Kelcey, Frederic R. Harris, Inc., O. J. Porter and Co.	Highway	19·1

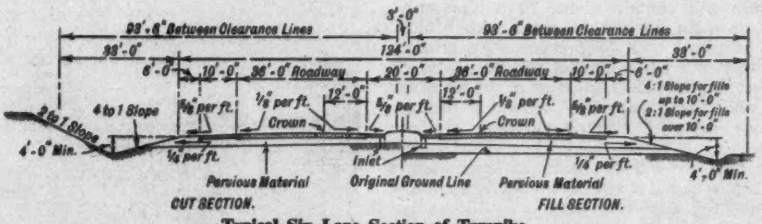
access or frontage rights allowed to contiguous property. These conclusions resulted in adoption of the general geometric standards given in Table I.

Actually no horizontal curvature of less than 10,000ft radius was used, and no long grades exceed 2 per cent in the 100 miles from the toll booths at the Delaware River to the town of Elizabeth. South of the Raritan River, the topography was found to be favourable; in this region the turnpike crosses farm land, except for the Camden area. The horizontal curvature ranged up to a radius of 180,000ft in order to obtain sufficient length. Excessively long tangents were not sought, as it was felt that they would make driving monotonous. North of the Raritan River the route traverses a heavily developed residential and industrial region with many cross streets, railways and extensive railway yards. In spite of these difficulties, long 3 per cent grades were confined to the major river crossings over the Passaic and Hackensack, and it was necessary to use the minimum radius of 3000ft at two places only. The remaining horizontal curves range from 3600ft to 38,000ft. A total of sixty-eight horizontal curves occur on the entire 118 miles of the turnpike. It was necessary to reduce the design speed to 60 m.p.h. at only two points. The restriction at these locations was due to the vertical sight distance over major bridges, where physical problems were difficult and costs excessive. It was decided to spiral curves at places where there were bridges which were on horizontal as well as vertical curves, and a series of compound curves closely following the locus of a true spiral were utilised for the transitions. A typical cross section of the six-lane portion of the turnpike is shown in the drawing reproduced here. In the initial stage of construction, which is now completed, the turnpike is composed of 96 miles of four-lane road and 22 miles of six-lane road.

FOUNDATION CONSTRUCTION

The total volume of earthwork moved in the course of constructing the road amounted to 51,800,000 cubic yards. To excavate this material it was necessary to utilise eight elevating graders each having a capacity of 1000 cubic yards per hour, twenty 2 to 3 cubic yard power shovels, about fifty tractor-drawn or self-propelled pneumatic scrapers and twenty-five draglines for mucking and ditching. For spreading purposes, bulldozers and power graders were used in the ratio of about two bulldozers to one power grader. The bulldozers were utilised generally for the preliminary levelling of large piles of material, and the graders for the final spreading and shaping. Compaction of embankments was performed by multiple-unit sheepsfoot rollers and by pneumatic-tyred rollers. The sheepsfoot rollers weighed not less than 3000 lb per linear foot of drum and exerted not less than 500 lb per square inch per footprint, each footprint having a minimum area of not less than 7 square inches. The pneumatic rollers weighed not less than 2500 lb per foot of width and had a load per tyre of not less than 220 lb per inch of tyre width. The use of conventional smooth-wheel rollers was permitted for auxiliary and final smoothing.

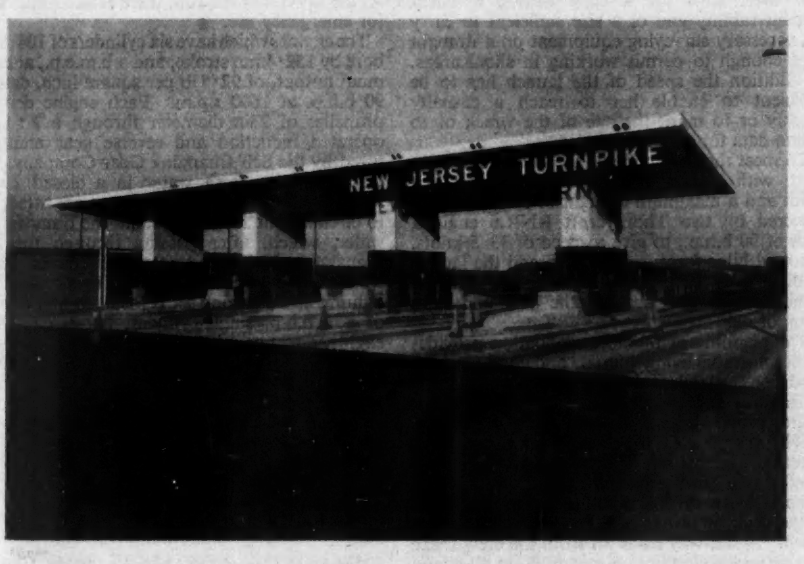
The specifications provided for the preparation of foundation areas before any embankment was placed. They required the consolidation of the top 12in of the underlying subsoil to 90 per cent of maximum density after all clearing, grubbing and top soil removal operations were completed. In many cases, however, because of the generally unfavourable weather, the unusual, perched water-table conditions, and the necessity of completing the work within the specified time, it became necessary to place a layer of porous fill at the bottom of embankments and to obtain consolidation by using "supercompactors" weighing 50 tons or more so that work could proceed on the top layers without delay. In shallow, swampy and mucky areas all unsuitable and unstable materials were removed by dragline or by dredging and the areas were backfilled with porous material to a minimum elevation of 1ft above tide water or ground water level.



Typical Six Lane Section of Turnpike

The control of the required density in the embankment material was considered to be a most important factor. Field density tests, representative of every 1000 cubic yard, were made in the bottom of all embankment areas. As the embankment work progressed these tests were reduced in frequency to a maximum of 1 per 3000 cubic yards, provided that the moisture content remained satisfactory and the density tests were reasonably uniform. Two factors which played a part in obtaining the required densities are worthy of mention, as they had an important bearing on the maintenance of a rapid and uniform rate of progress. The first was that spreading should be done by a method that would give a more or less uniform density in the loose material before any compacting operation was begun. It was rather convincingly established during the progress of the turnpike work that bulldozer equipment did not give this desired uniformity but that power graders did. Where bulldozers alone were used it was found that very uneven surfaces resulted and that considerable effort was required to correct this condition. Secondly, it was noted that materials placed in 6in layers throughout provided much more uniform surfaces than those placed in deeper layers, even when "supercompactors" were used to consolidate the greater depth.

(To be continued)



Toll Plaza

WET-WEATHER DAMAGE TO SURFACE DRESSINGS.—Road Note No. 14, published recently by H.M. Stationery Office for the Department of Scientific and Industrial Research, describes the technique of using a new agent, D. S. 2274, for preventing wet-weather damage to surface dressings. The new agent is used as a solution in creosote: it replaces cetyl pyridinium bromide, previously recommended, but now difficult to obtain. The agent is applied to the interface between the stone chippings and the sprayed film of tar or bitumen. The application is made either by coating the chippings with the creosote solution in a bituminous or concrete mixer, or by sprinkling the solution on to the freshly laid binder film before the chippings are spread.

Garrison Dam Project, North Dakota

THE Garrison Dam and Reservoir project at Riverdale, North Dakota, U.S.A., which is being constructed by the Corps of Engineers of the United States Army, will form one of the key units in the scheme for the control and development of the water resources of the Missouri River Basin. The dam will be located about 77 miles up river from Bismarck and is part of a plan which envisages the construction of 105 reservoirs. It is intended to impound the flood waters of the Upper Missouri River in the interests of irrigation, power development, flood control and to improve the navigation on the Missouri and Mississippi Rivers during low water periods.

Although the development of the Upper Missouri River was under consideration prior to 1900, it was in 1944 when Congress authorised the project, and it was not until 1947, after a year of preparatory work, that the excavation of the dam proper commenced. The dam, of rolled earth fill design, will have a length of 12,000ft with a width at base of 2600ft and a width at top of 60ft, while the height above the stream bed will be 210ft, the top of the dam being 1875ft above mean sea level. When completed the dam will contain about 70 million cubic yards of earth fill and be faced with 650,000 cubic yards of rock to prevent wave erosion. An impervious earth blanket will be placed on the river bed for 1250ft upstream of the toe of the dam, while the downstream part will be of semi-pervious material over a pervious drainage blanket.

The spillway will be 1825ft in height above mean sea level and it will have a discharge well in excess of the maximum amount of flood water liable to arise. Along the length of the 1444ft spillway will be twenty-eight Tainter crest gates, each 29ft by 40ft, and the controlled discharge will flow into a stilling basin, where the energy of the water will be dissipated. For the release of the water in the reservoir eight tunnels have been driven through the west abutment, one of 26ft and two of 22ft diameter for flood control, &c., and five of 29ft diameter for power purposes.

Between the power house and the portals of the power tunnels surge tanks are to be constructed so as to prevent sudden changes of pressure in the penstocks. Within the power house the initial power installation will consist of three generators developing a total output of 240MW, and this will be raised, at a later date, to 400MW by the addition of two more units.

The drainage area above the dam amounts to 180,940 square miles so that it will control nearly one-third of the total volume of flow of the Missouri River. On completion of the dam the reservoir formed will have a maximum normal area of 390,000 acres, and be 200 miles in length, while the corresponding minimum figures will be 133,000 acres and 120 miles. The maximum normal pool capacity of the reservoir will amount to 23 million acre-feet, including flood control of 4,250,000 acre-feet, 13,850,000 acre-feet for multiple purpose uses and dead storage of 4,900,000 acre-feet. When full, the reservoir will be 14 miles wide at points and have a depth of 200ft along the line of the former river channel.

As part of the Garrison dam project in North Dakota, Ferranti, Ltd., will be supplying nine single-phase 13·2/230kV, 33·333MVA generator transformers, each having an installed weight of 90 tons, with water-cooled, forced-oil circulation forming three-phase, 100MVA banks. Each bank will be connected to the 13·8kV output of one 80MVA hydro-electric generator, which has a maximum continuous rating of 97·8MVA. The tender was submitted by Ferranti Electric Incorporated of New York, a subsidiary of Ferranti, Ltd., of Hollinwood, and the price was the lowest by 176,100 dollars in spite of having to pay a duty of 85,000 dollars, representing a saving to the United States Government of over £90,000. Although there is a "Buy-American" Act, the American Army buying regulations provide for the consideration of foreign tenders, when there is a minimum price differential of 5000 dollars, by the Secretary of the Army.

Mersey Survey Launch

THE Mersey Docks and Harbour Board will shortly put into service a survey launch, which has been designed and built at the Southampton yard of John I. Thornycroft and Co., Ltd. Named "Surveyor V," the launch has recently completed trials and the photograph, reproduced herewith, shows the boat on a demonstration run at Southampton.

Hydrographic surveying of the river channels and dock entrances will be the principal work of the launch. The rapid changes which take place in the river and docks call for frequent surveys; one dock entrance has to be surveyed on alternate days and the completed charts are usually available to the pilots within six hours after the commencement of the survey, an achievement demanding a high degree of efficiency of both personnel and equipment. Another duty, requiring absolute accuracy to ensure the safety of the large volume of river traffic, is the siting and marking of the correct positions of buoys. The work calls for a craft having excellent manœuvrability and of a size sufficient to carry the necessary surveying equipment on a draught light enough to permit working in shoal areas. In addition the speed of the launch has to be sufficient to enable her to reach a casualty quickly or to mark the site of the wreck or to obtain data for salvage.

Mersey Survey Launch "Surveyor No. 5"

To meet the requirements the launch has been built, with a length overall of 50ft by 11ft beam and a maximum draught of 3ft 8in, and is powered by two Thornycroft RNR.6 engines, each of 90 b.h.p., to give a speed of 13·5 knots. A round bilge form was adopted and the launch is diagonally planked with a double skin of mahogany on elm timbers, the keel and stern being of oak.

The planning of the accommodation provides for comfortable living quarters and good working conditions, excellent ventilation being ensured by natural supply ventilators and electric extractor vents. Right forward is the chain locker, which is separated from the crew space by a watertight bulkhead. The latter space, which is comfortably furnished with cushioned seats, lockers and a drop-leaf table, has direct access to the deck by means of a ladder and an escape hatch. A stairway leads aft from the crew space to a spacious wheelhouse having good all-round visibility, observation platforms to port and starboard aft, a 9in searchlight mounted on the roof and controlled from inside, and a plotting table. Against the aft bulkhead is a battery-operated Kelvin and Hughes echo sounder recorder with a sounding rate of 533 per minute and an effective range from a few inches depth of water to 540ft. The two 24V batteries for operating the echo sounder are stowed beneath the wheelhouse flat.

The engine-room is aft of the wheelhouse, and further aft is a small vestibule with a toilet to port and a well-equipped galley to starboard. From the vestibule, sliding doors give access to the saloon, which is furnished with cushioned seats on each side and with wardrobes. A hinged table in the centre permits a clear passage through the saloon and double sliding doors to the cockpit, which is fitted with batten seats. The aft peak houses the operating gear for the twin rudders, which give the launch a turning circle of small diameter.

Engine-Room

A stairway gives access to the well-ventilated engine-room, which provides ample space for the power units consisting of two Thornycroft RNR 6 diesel engines. The bulkheads, sides and underside of the floor are lined with asbestos and the roof has been made portable to permit the easy removal of the engines for overhaul. At the aft end of the roof there is an escape hatch for emergency use.

The engines which have six cylinders of 104·8mm bore by 152·4mm stroke, and a b.m.e.p., at maximum output, of 92·5 lb per square inch, develop 90 b.h.p. at 1600 r.p.m. Each engine drives a propeller of 27in diameter through a 2 : 1 oil-operated reduction and reverse gear manufactured by the Self Changing Gear Company, Ltd. Cooling is by fresh water in a closed circuit with heat exchanger. Two pumps are fitted, one to circulate the fresh water and the other for sea water, which, after passing through the heat exchanger, is injected into the rubber motor exhaust piping. A Stuart Turner auxiliary lighting and charging set is installed and consists of a 1 b.h.p. single-cylinder, two-stroke diesel engine, direct coupled to a 500W, 25/35V, shunt-wound battery charging dynamo. The launch which is capable of a speed of 13·5 knots, achieved 13·8 knots on trial, but will run normally at about 12·5 knots. In service, frequent and rapid manœuvres will be required. The speed of the engines and the operation of the reverse gears are controlled from the wheelhouse by a Thornycroft combined single-lever control.

FLOOR HEATING.—The Invisible Panel Warming Association, 136, Grand Buildings, Trafalgar Square, London, W.C.2, has published a leaflet describing the construction of heating panels embedded in the floors of houses or other dwellings: it is entitled "Floors and Floor Finishes in Relation to Embedded Panels."

SURFACING CONCRETE FLOORS.—We have received from the Metropolitan Construction Company, Ltd., 66, Queen Street, London, E.C.4, a brochure describing the "Mettexture" process of roughening concrete floors, to provide a key for topping, or to make an anti-skid surface. The process was described in THE ENGINEER of March 9, 1951.

Aircraft Docking Facilities

A VERY important factor in the economic operation of civil aircraft relates to the time that a machine is grounded for maintenance and servicing reasons. This factor has now assumed particular prominence with the advent of jet-propelled aircraft. The modern passenger-carrying aircraft is a highly complicated mechanism, easily vulnerable to external damage, and thus requires careful handling by ground crew maintenance personnel. Every effort must always be made to maintain a high state of operating efficiency in order to utilise the aircraft's maximum availability to earn revenue during its life, and maintenance must be completed in the shortest possible time to meet these requirements. A detailed study of the construction of the whole aircraft must be made in order to produce well-planned maintenance schedules, together with intensive time and motion study of the operations carried out, so that maintenance personnel can complete all operations at the maximum efficiency.

Due to the shape and varying heights of the modern aircraft, and to implement the above requirements, adequately designed platforms and equipment must be available. These platforms and their equipment have been termed in recent years " aircraft docks " and embrace all facilities to service aircraft, such as platforms, both static and movable, pneumatic lines, engine oil draining, hydraulic circuit testing, lighting, aircraft electrical power supply, fire-fighting appliances, check sheet boards, offices, clothing lockers, &c.

These docks may be divided generally into two categories, according to the maintenance checks for which they are required, i.e. movable staging for checks I, II and III, and static staging for check IV and certificate of airworthiness.

When designing either type of dock the following considerations must be borne in mind in order to produce a piece of equipment which will assist in every way the points mentioned above : a structure which is light, robust and requires little attention, platforms at the most convenient height for all maintenance operations, with adequate working space, non-skid resilient floors, and as much space as possible beneath the platforms free from bracing. The days when a couple of trestles and a gangplank slung between were considered sufficient to carry out complicated maintenance operations are long past ; so also are the use of heavy tubular steel structures with their attendant network of cross bracing beneath platforms. Thus a new approach to this problem was envisaged, calling on the resources of the structural engineer, the mechanical handling engineer, liquid handling and fire-fighting specialists, to mention but a few.

The first essential requirement is a structure to which all other equipment is complementary. Tiltman Langley Laboratories Ltd. claims to have found in the " Keylock " system of structural assembly a method which allows complete flexibility in design, while preserving the chief advantages of prefabrication, thus allowing the movable structures for checks I, II and III to be broken down and easily transported abroad, and the fixed structures for check IV to be altered quickly or further platforms added should they be required.

The system employs basically an extruded aluminium alloy channel, 1in square, in which are punched keyholes. Into these are fitted precision die-cast aluminium alloy keys and locking elements. Structures of any required configuration and strength can be built up very quickly by a simple process of inserting the specially shaped keys into the slots which are locked into position and kept rigid by driving a tapered pin through a hole. Complex structures can be built up without using any tools except a hammer, with obvious economies in time and the use of skilled labour.

It will be seen from the foregoing that if it were considered necessary to employ a light mobile dock at some airline terminal abroad, by breaking down the structure into small units, which is easily accomplished by driving out the taper pins and removing the locking elements with a screwdriver, the whole equipment can easily be transported by air and reassembled on site.

Great assistance could be obtained by employing this system of construction for equipment employed in the salvaging of crashed aircraft, because all forms of staging, lifting tackle and cranes can be built up from basic units.

In recent months Tiltman Langley Laboratories Ltd., has prepared designs of maintenance docks for two different types of aircraft, employing the " Keylock " system as the basic structure. One is suited for a twin-engined tail wheel aircraft, and we illustrate a check IV dock, almost assembled, for a twin-engined nose wheel aircraft.

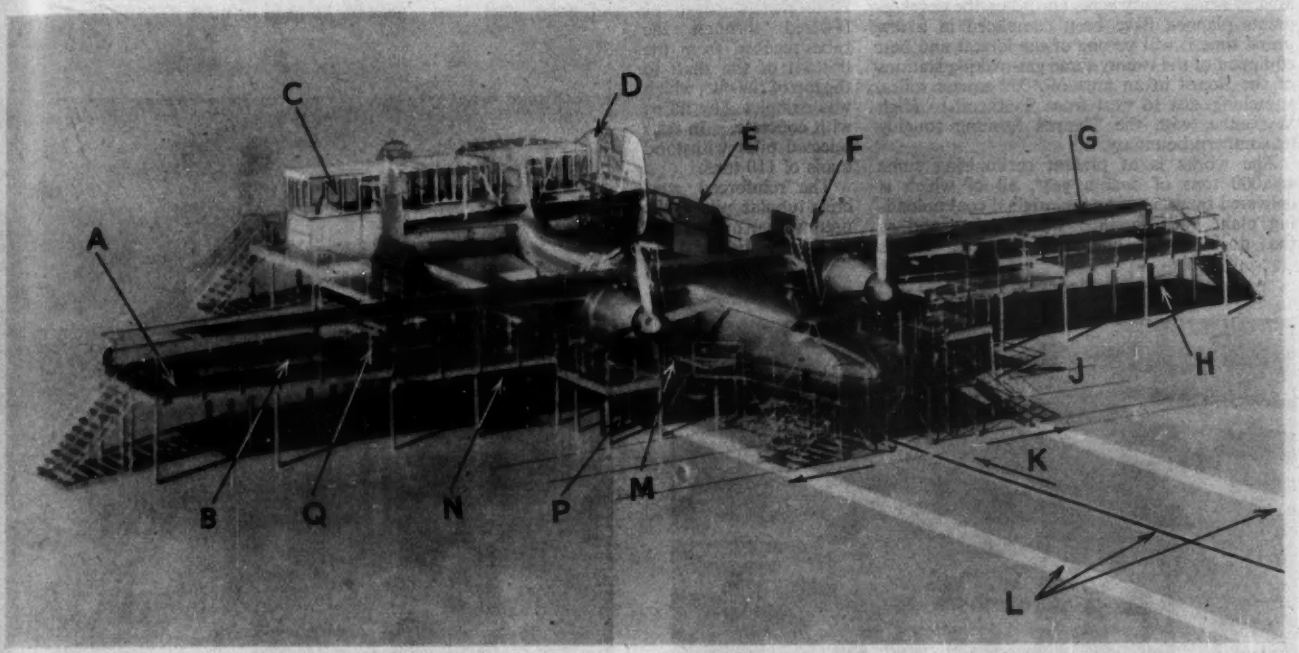
In the former, all the stands are mobile, so that, once the aircraft has been positioned in the hangar, they can be manœuvred quickly into place around the aircraft from their stowed position against the hangar sides.

In the latter the structure is fixed to the hangar floor and working platforms surround the aircraft completely except for two movable sections around the nose. Maintenance personnel are thus able to move around the aircraft at the various platform levels.

It will be seen from the photograph that there is an absence of cross bracing, &c., beneath the platforms, thus giving access to the underside of the engines, main wheels and fuselage.

Tiltman Langley Laboratories, Ltd., has also envisaged other units of equipment for airline use, including conveyor freight loading ramps, universal passenger entrance stairs, various forms of trolley, and a demountable mobile crane, all possessing the advantages of lightness with strength, anti-corrosion, speedy assembly, and ease of transport.

The company has also been engaged on the design of an underground propeller turbine engine test bed for one of the leading airlines of Great Britain, together with designs for testing aircraft auxiliary equipment with special reference to a hydraulically operated test rig for linear actuators.



A.—Fixed structure completely surrounding aircraft
B.—Well platform for access to underside of wing
C.—Office accommodation
D.—Platforms for access to fin and rudders
E.—Check sheet boards and clothes lockers
F.—Step ladders for access to upper surface of wing
G.—Hinged rails fold to platform when aircraft is moved in or out
H.—Space under platform free from cross bracing
J.—Port and starboard nose stands move in direction of arrows to clear engine nacelles
K.—Aircraft positioned in dock by winch in direction of arrow
L.—Wheel guide lines on hangar floor
M.—Hinged platforms to allow passage of four-bladed airscrew
N.—Fluorescent lighting fitted to underside of platform
P.—Fire extinguisher equipment
Q.—Adjustable trestles for wing removal.

Permanent Dock for Nose Wheeled Aircraft

Coal Handling Plant at Nine Elms Gas Works

A new coal handling plant, which forms part of an extensive modernisation scheme at the Nine Elms works of the North Thames Gas Board, has involved the construction of a new off-shore jetty 360ft long by 47ft wide, a 3200-ton storage bunker and the installation of three unloading cranes, designed to handle up to 250 tons of coal an hour.

AN important stage in an extensive development programme now being carried out at the Nine Elms gas works was reached recently when a new jetty and coal-handling plant was put into service. This works has been manufacturing gas for nearly a hundred years and with its present maximum daily output of 29 million cubic feet of gas is one of the largest stations of the North Thames Gas Board. It covers an area of some twenty acres and when the developments planned have been completed in a few years' time it will be one of the largest and best equipped of the twenty-three gas-making stations of the Board in an area of 1059 square miles, stretching east to west from Southend to High Wycombe, with the Thames forming roughly its southern boundary.

The works is at present carbonising some 440,000 tons of coal a year, all of which is delivered by water. As the original coal unloading plant built in 1905 was obsolete and as the dock could only accommodate vessels of up to 1200 tons capacity, an essential part of the improvement scheme was to replace the plant with modern equipment capable of handling the Board's latest 2600-ton colliers. The new coal unloading and handling plant was authorised by the former Gas Light and Coke Company in 1946 and work on it began in 1948.

We reproduce some photographs of the new installation, which consists of an off-shore jetty, three electric grab cranes, a reinforced concrete storage hopper, a belt conveyor system to transfer coal from the jetty to the hopper or stock piles, and pumping equipment to supply river water to the gas works. The main contractors for the civil engineering work in connection with the scheme, under the supervision of the Board's chief engineer, were Holloway Bros. (London), Ltd., and the consulting engineers were Rendel, Palmer and Tritton.

The new jetty has an overall length of 360ft with a width of 47ft, and one of the photographs reproduced on this page shows it in process of construction. It is carried on 124 concrete piles of 24in external diameter. An interesting piling procedure was adopted for this structure, whereby reinforced concrete tubular pile shells 45ft long and 19in nominal bore were first sunk into the river-bed in rows of eight. Through these tubes a further shaft some 21ft deep was sunk into the river-bed and by means of a special cutter three bulbous cavities were spaced in the shaft length. Prefabricated cages of reinforcing steel then lowered through the tubes reached from the bottom of the shaft to the top of the pile, which was completed by filling with concrete. In tests selected piles withstood loads of 110 tons.

The reinforced concrete tubular pile shells used were manufactured by Spun Concrete, Ltd., of Rye Harbour, Sussex, to the specification of the consulting engineers and were produced in one complete length by the centrifugal spinning process. This method of construction was adopted to obtain an extremely dense concrete, which would be resistant to the chemical action of sea water and abrasion due to tidal movement. The makers point out that the spinning of tubes of such dimensions for use on piling work represented a completely new development in this country and, coupled with the close tolerances demanded by the specification, presented a number of problems.

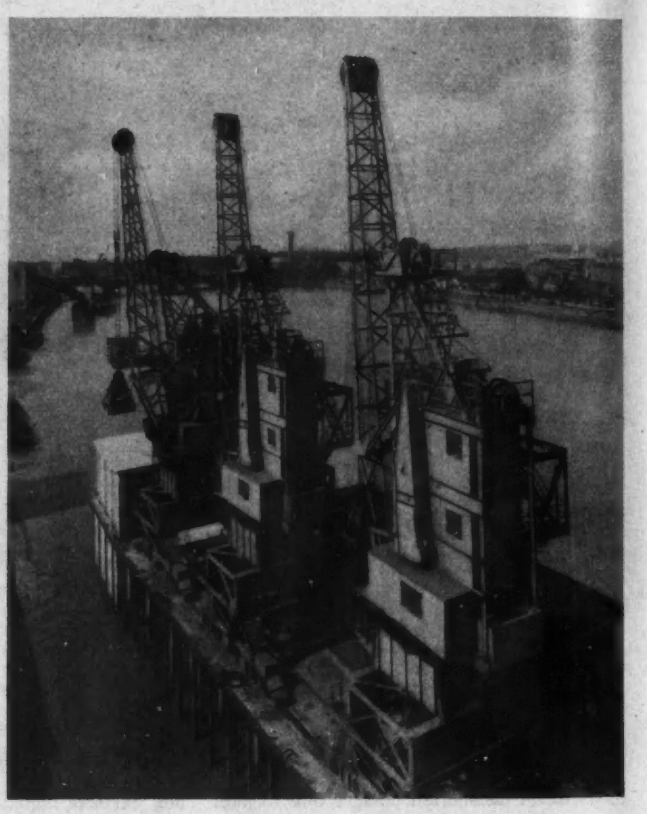
Another interesting point in the manufacture of these piles was a specially designed concrete centralising block for the location of the reinforcement. Each block was produced by the centrifugal spinning process as a separate unit and ultimately incorporated in the spinning of the tube.

Seven sets of spring fenders are spaced along the river face of the jetty and in each fender four heavy springs are mounted.

Jetty Under Construction

The three 9-ton electric portal coal unloading cranes on the jetty were supplied by the Clyde Crane and Engineering Company, Ltd., of Mossend, Lanarkshire. These cranes are a development of those described in some detail in THE ENGINEER of December 28, 1945. They are carried on tracks of 36ft centres and have a working radius from 19ft to 70ft. Each crane is fitted with a 4-ton capacity four-rope scraper-type grab, and is designed to handle up to 250 tons of coal an hour—with this capacity two cranes are easily capable of unloading the largest collier in service in six to seven hours.

In these cranes the weight of the grab is balanced and the coal is discharged into a receiving hopper incorporated in the crane carriage. The design reduces the amount of slewing in normal working to a minimum and adjacent cranes can work close alongside each other out of the same hold without fouling. The position of the mast sheaves relative to the jib gives approximate level luffing without the use of any secondary gear on jib head or mast.



Coal Handling Cranes

Each crane is mounted on four three-wheeled equalising bogies, with two individual motors driving two wheels of two bogies and powerful rail clamps are provided on each bogie. The cabin is mounted high up and well forward to give the driver a clear, uninterrupted view of the grab movements.

Power is supplied to each crane by a flexible trailing cable arranged to wind on a cable reeling drum mounted under the portal platform.

The control equipment used on the cranes is of a heavy duty contactor type, designed for operation by master controllers in the driver's cabin. These controllers are on the right-hand side of the driver, with their universal handle arranged to move in the required direction of the load. The luff master controller is placed on the left of the crane driver, also with its handle arranged to move in the required direction of the grab. In the hoist/slew controller handle a push-button is incorporated, which, when depressed, causes the holding rope drum to be de-clutched from the hoist gear and the holding

Coal Bunker at Nine Elms Gas Works

Pump House

brake to be applied, thus opening or closing the grab as required ; emergency stop switches are incorporated in the cabin to trip the main circuit breaker on the crane portal.

The coal from the grab receiving hopper feeds a system of belt conveyors to a concrete storage bunker. On its way to the bunker the coal is weighed by means of an automatic belt weighing unit. The storage bunker, illustrated above, has a capacity of 3200 tons and from it the coal is drawn as required by conveyors for supplying the retort houses. The main conveyor system from the cranes to the storage bunkers is designed to handle up to a rate of 620 tons of coal an hour; from the bunkers the coal is fed by a three-speed feeder to either the stock ground or retort houses.

A pump house built into the new jetty structure contains three pumps, illustrated above, which supply some 180,000 gallons of filtered river water an hour to the gas works for cooling and other purposes.

CORYTON REFINERY.—The all-steel first-stage fractionating tower, measuring 102ft in length by 16ft diameter and weighing about 80 tons, was recently delivered by road from the works of G. A. Harvey and Co., Ltd., Greenwich, to the refinery building for the Vacuum Oil Company at Coryton, Essex.

APPRENTICESHIP IN THE GAS INDUSTRY.—A booklet, *Pathways to Opportunity*, to be published by the Gas Council, outlines the schemes of apprenticeship open to boys who wish to join the gas industry It describes the training the entrants to the industry will receive and the opportunities which exist for advancement and promotion.

National Chemical Laboratory at Poona

IT was announced by the Indian Council of Scientific and Industrial Research that Professor James W. Mcbain, F.R.S., the first Director of the National Chemical Laboratory, Poona, had laid down his office on July 16th and was leaving for the United States to rejoin the research laboratories of Stanford University in California. He has been associated with the Laboratory since its inception in 1946, and will be succeeded by Professor G. I. Finch, F.R.S., Professor at the Imperial College of Science and Technology, London.

The National Chemical Laboratory is one of the eleven central research institutes governed by the Council of Scientific and Industrial Research. The initiative for their inception is largely due to Mr. Jawaharlal Nehru, who combined the portfolios of Prime Minister and Minister of Scientific Research in the early days of the National Government. Mr. Nehru himself is a science graduate of Cambridge University and has throughout been very enthusiastic about the creation of national research laboratories in India. The ambitious programme involving an expenditure of more than Rs. 6 crores (£4·5 million) was taken in hand soon after the war, and the last of the institutes to be opened was the Central Road Research Institute at New Delhi, officially inaugurated by the Prime Minister on July 16th. The remaining institutes and their directors are (1) National Physical Laboratory, under Dr. K. S. Krishnan ; (2) National Metallurgical Laboratory, Jamshedpur (Dr. G. P. Contractor) ; (3) Fuel Research Institute, Jealgora (Dr. J. W. Whitaker) ; (4) Central Glass and Ceramics Research Institute, Calcutta (Dr. Atma Ram) ; (5) Central Building Research Institute, Roorkee (Dr. J. N. Mukherjee) ; (6) Central Drug Research Institute, Lucknow (Dr. B. Mukherji) ; (7) Central Food Technological Research Institute, Mysore (Dr. V. Subrahmanyan) ; (8) Central Leather Research Institute, Madras (B. M. Das) ; (9) Central Electro-Chemical Research Institute, Karaikuli (Dr. A. Joga Rao). The Road Research Institute is under Dr. Ernst Zipke.

Scientific work at National Chemical Laboratory falls under seven major divisions : biochemistry, organic chemistry, inorganic chemistry, high polymers, chemical engineering, physical chemistry, survey and information. In the chemical engineering division experiments are being made for the production of certain phosphatic fertilisers not yet manufactured in India. A plant is being assembled both for the production of phosphorus from phosphate from Trichinopoly in the south and subsequently for processing this phosphorus into the fertiliser known as triple super-phosphate. The division is also setting up a pilot plant for the preparation of cellulose pulp from indigenous raw materials such as bamboo, reeds, grasses and certain varieties of wood. The object is to use this pulp in the manufacture of rayon, plastics, certain kinds of paper and photographic film. The biochemistry division has recently been successful in developing a process for the production of citric acid and calcium gluconate by the fermenting action of fungi on sugarcane and glucose. Developed in the Laboratory with a view to commercial exploitation, the process has been made over to a firm which is being advised in the setting up of a bench pilot plant. In the plastics and polymers division, methods for making resins by the exchange of ions are being investigated, use being made of such indigenous raw materials as coal, cashew-nut shell liquid, agricultural waste and naphthaline. The survey and information section gives advice to would-be small investors and advises the State Governments on the development of cottage industries.

American Engineering News

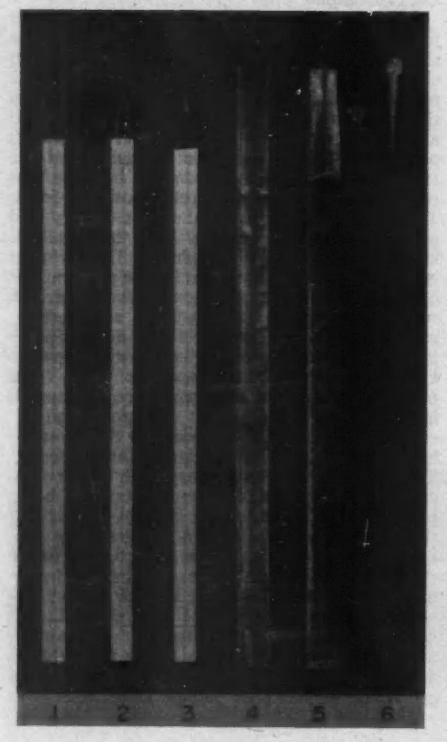
(By our American Correspondent)

A Waterproof Internal Strain Gauge

A waterproof internal strain gauge has recently been developed at the National Bureau of Standards and has been found to provide a simple method for determining internal strain, thermal expansion or drying shrinkage in hardened concrete, for which purpose the gauge can be embedded in concrete during the fabrication of a test specimen or a structural member. The development follows earlier work at the N.B.S. on the volume changes in concrete during freezing and thawing, in which a mercury-displacement dilatometer was used and which indicated a possible relationship between the resistance of a concrete specimen to frost action and the strains produced during freezing and thawing. The dilatometric method, while satisfactory for the exploratory phases of the study, was slow and imposed a limit on the maximum size of the specimen and, consequently, upon the maximum size of the aggregate that could be used in preparing the concrete. The N.B.S. waterproof strain gauge is a modification of the commercially available " SR-4 " bonded-wire resistance strain gauge manufactured by the Baldwin Locomotive Works, Eddystone, Pa. The " SR-4 " gauge consists of a loop, grid or flat helix of 0·001in diameter cupro-nickel or other wire between layers of paper bonded together by a nitrocellulose adhesive, or within a thin bakelite laminate. A Wheatstone bridge circuit supplies the current to be passed through the gauge element, and once the gauge constant relating change in resistance to change in strain has been set on the dial, strain may be read directly in micro-inches per inch. The simplicity of use, expendability and high sensitivity of these gauges

have been responsible for their wide use in the experimental stress analysis of metals in the United States in recent years.

In present concrete theory, there is some uncertainty about the effect of local irregularities in strain upon the operation of gauges having gauge lengths of 1in or less, when the gauges are situated near particles of coarse aggregate. Only one design of "SR-4" gauge now available appears to be of satisfactory gauge length for use with concrete; this is the "A-9" gauge, having a nominal gauge length of 6in. Since none of the commercial "SR-4" gauges are waterproof, however, the concrete member to be tested must



"A-9" Waterproof Strain Gauge

undergo some drying treatment before such a gauge can be bonded to the concrete surface. For satisfactory operation, it has been found that the leakage resistance between the sensing element and the ground must be maintained high (over 500 megohms), making it necessary to keep the gauge perfectly dry at all times. Waterproofing of the present gauge is accomplished by bonding an "A-9" gauge to the inner sides of a rectangular metal foil envelope with a thermc-setting adhesive; a rolled brass shim, 0·001in thick, has so far proved the most satisfactory metal foil. The brass shim stock may be bent, folded, or otherwise worked without damage and appears to be impermeable to water vapour in this thickness. The metal-encased gauge is embedded within a concrete specimen by insertion at the desired position and orientation immediately after the placing of the fresh concrete. Transfer of strain from the hardened concrete to the gauge is provided by the bond of the cement-water paste in the concrete to the metal foil. Calibration is not required because the gauge constant, as determined by the manufacturer of the gauge element, is the same for the waterproof and for the standard gauge.

Seven basic steps are followed in making up the N.B.S. waterproof strain gauge, illustrated in the accompanying engraving. In the first instance, the "A-9" gauges are obtained from the manufacturer without the customary felt covers. The single 6in loop of strain-sensitive wire comprising the sensing element for each gauge, which is unprotected on one side, is covered by strips of ordinary typewriter paper and bonded by a nitro-cellulose cement (1). Particular care is taken to prevent the displacement of the strain-sensitive wire during the placing of this paper cover. Natural rubber-insulated 24 gauge solid copper lead wires in suitable lengths are then lap-soldered to the leads of the gauge (2); the soldered joints are cleaned and covered with electrical tape (3). In the next step, a flat rectangular envelope, ¼in by 8in, is prepared by folding lengthwise and soldering a strip of 0·001in brass shim. One end of the flat "tube" thus formed is folded over and soldered closed; the other end is left open for the insertion of the gauge and the insulated lead wires (4). Both sides of the paper-sandwiched gauge element are then coated with a suitable adhesive, and the gauge is inserted into the brass envelope with a portion of the insulated leads as well as the soldered joints inside the envelope (5 and 6).

After manipulation to remove any entrapped air from the envelope, the gauge assembly is placed between two sheets of 1·4in thick rubber, backed by plywood boards. Clamps are used to press the flat envelope surfaces together. The clamps near the closed ends of the gauges are tightened first to move all excess adhesive toward the open end of the envelope and to make the adhesive layer as thin as possible. After 10 to 15 minutes, the clamps near the open ends are tightened. The pressure exerted upon the gauges through the cushioning layers of rubber is much greater than that recommended by the manufacturer, but this procedure has caused no damage to any of the gauges produced thus far. Next, each group of gauges, while in the clamping device, is cured for 3 hours at 150 deg. to 160 deg. Fah., or for 48 hours at room temperature. The waterproofing of the gauges is completed by filling the space remaining near the open end of the envelope with hot cerese wax, to produce a perfect vapour seal. The finished gauges are stored under water for one week with the remote ends of the insulated lead wires kept dry. During this time the gauges are periodically checked for leakage resistance between gauge element and foil envelope. Should the leakage resistance for any gauge decrease during this time, or should it be lower than 500 megohms, the gauge is discarded. The proportion of defective gauges prepared in this manner is negligible. Before placing in concrete each gauge is strained and unstrained manually by exerting a tensile force upon the gauge several times. This procedure obviates the necessity for a later "shakedown" to stabilise the zero of the gauge by the customary method of applying and releasing a load upon the test specimen prior to testing.

The gauge has performed satisfactorily in stress-strain determinations made upon cylindrical concrete specimens in compression, in measurements of drying shrinkage of concrete prisms dried for 100 days, and in the measurement of linear thermal expansion. Dial-gauge length comparators and Tuckerman optical-lever strain gauges have been used to evaluate the performance of these internal strain gauges. Work is now proceeding to evaluate the stability of the internal gauges over longer periods and to compare directly the performance of the gauges with that of the mercury-displacement dilatometer. The testing of mortar or concrete models of structures appears to be a promising field of application for such internal strain gauges.

Prevention of Floods in the Western United States

Every available reservoir of the U.S. Bureau of Reclamation, including those built primarily or exclusively to store water for irrigation and power generating purposes, is now put into service to help meet the threat of floods on rivers in the western part of the U.S. in the spring. The waters in twenty-nine reservoirs either were drawn down or evacuated, to hold back as much of the waters from the large snow melts as possible. The waters discharged can be replaced from the later snow melts, so as to assure supplies for irrigation and power generation in later dry seasons. Altogether, space is being made available in reclamation reservoirs to catch and hold back some 14,000,000 acre-feet of flood waters. Though this reservoir space is small compared with the volume of waters released by the spring snow melt, every inch by which the flood crests can be reduced will help to protect lives and property. In some areas, such as along the Boise River in Southern Idaho, the reclamation reservoirs are expected to hold floods and property damage to a minimum, whereas an uncontrolled river would be likely to take a heavy toll.

Most of the reclamation reservoirs—particularly the older ones—were built to store water for irrigation, power generation and other uses, rather than for flood control. Certain of the newer reservoirs, such as those behind Shasta dam on the Sacramento River, in California, and Hoover dam, on the Colorado River, on the Arizona-Nevada border, were designed for flood control space and for water conservation. There has not been a major flood along the Lower Colorado River since Hoover dam went into service in 1935. Until enough of the bigger reservoirs, with designed flood control space, are built, much of the West will continue to be at the mercy of the elements. Wherever local flood protection can be enhanced by lowering irrigation reservoirs in anticipation of the heavy spring run-off, this is done. Many of the reclamation reservoirs are operated by the local water users' organisations, or under contracts made primarily or exclusively to provide irrigation service. The Bureau of Reclamation is co-operating closely with these organisations in making advance flood preparations. For example, the reservoir at Grand Coulee dam was drawn down to a level of 3,204,000 acre-feet on May 1st, a volume of water 1,750,000 acre-feet less than usual, in anticipation of increased spring flow from the Columbia River. On the Boise project in Idaho both the Anderson Ranch and Arrow Rock reservoirs were used for flood control; the former was drawn down to 236,700 acre-feet (427,000 acre-feet of water last year) and the latter to 70,700 acre-feet (182,000 acre-feet last year). These operations so far have held the flow of the Boise River to bank-full discharge, despite an extremely high run-off. Incidentally, the Wood and other rivers in the Idaho-Oregon area, where no reservoir controls are available, have experienced the largest floods in recent history. The Middle Snake River at Weiser, Idaho, has undergone one of the largest run-offs on record. To meet flood damage threats, 635,000 acre-feet of capacity was held in the Jackson Lake and American Falls reservoirs of the Minidoka project and the release of water into the Snake from Jackson Lake was limited to 500 cubic feet per second. On the Central Valley project in California the Shasta dam and reservoir brought the record-breaking spring run-off of the Upper Sacramento River under control; the reservoir had been drawn down earlier to catch the snow melt. It was almost brimful, for the first time in its nine-year history; it contained 4,500,000 acre-feet of water on May 14th and it was expected that the lake would rise to 4,522,000 acre-feet with 1ft of water flowing over the spillway gates. During the height of the flood season the reservoir held more than 1,000,000 acre-feet of storage space to catch and hold peak floods along the Upper Sacramento River. Lake Mead, on the Colorado River, behind the Hoover Dam, controlled what appears to be one of the largest run-offs of record in the river. Waterflow from the reservoir was limited to about 8000 cusecs, as compared to a potential flood peak, without control, of perhaps 220,000 cusecs.

NIOBIUM AND PHOSPHATES IN UGANDA.—Representatives of several well-known mining and chemical groups are travelling to Entebbe, Uganda, for discussions to be held with Uganda Government and Development Corporation during the last days of this month. As a result of these discussions it is hoped that the firms and the Uganda Development Corporation will form a syndicate for further exploration and in due course, working of niobium, phosphates and magnetite deposits which surround the Sukulu Hill near Tororo. It is the hope of the Protectorate Government that these minerals will be extracted and separated to ensure the establishment of industry producing phosphorus, superphosphates, fertilisers, and, at a later stage, iron and steel products. Adequate power will be available when the Owen Falls hydro-electric plant comes into operation to make possible the electric smelting of both phosphorus and iron. Plans are under consideration for manufacture of sulphuric acid at the Kilembe copper mine now under development on the slopes of Ruwenzori Mountain. The railway extension at present under construction is expected to reach Kilembe by the end of 1954.

Industrial and Labour Notes

Engineering Wages

It was announced on Thursday of last week that the Engineering and Allied Employers' National Federation had rejected the claim for an increase of £2 a week in the wages of adult male workers in the engineering industry. This claim, it will be recalled, was put forward on June 26th by the Confederation of Shipbuilding and Engineering Unions, on the basis of the rise in the cost of living and in the profits of the engineering industry since the increase of eleven shillings a week was granted last November. Prior to the submission of the claim by the Confederation, the national committee of the Amalgamated Engineering Union, at its annual conference in May, unanimously adopted a resolution calling for an increase of £2 a week.

In its reply to the claim, the Engineering and Allied Employers' National Federation said that to grant it would be against the national interest in present circumstances. In spite of the union's contention, the concession of the claim would not be justified by the profits of the engineering industries, which were already heavily taxed, nor would it be warranted by the rise in the cost of living, against which there had been such compensations as income tax reductions and increased family allowances. The employers added that they would not be unwilling to reward increased effort on the part of the individual worker. To increase costs of production, however, was a sure way to depression and unemployment. As the country was faced with a revival of producing power, particularly in Germany and Japan, which had again become challengers in world markets at very competitive prices, what was needed to safeguard its future was a wholehearted effort in every industry to produce more at less cost.

Representatives of the thirty-eight unions which comprise the Confederation were expected to discuss the decision of the Employers' Federation during the present week. The annual conference of the Confederation is to be held next week, when, undoubtedly, wages questions will be fully debated. Meanwhile, it is understood that a special meeting of the national committee of the Amalgamated Engineering Union will take place tomorrow, August 9th, to consider the employers' rejection of the claim.

Changes in Wage Rates

The Ministry of Labour has reported that changes in wage rates which came into operation during June resulted in an aggregate increase of approximately £146,000 in the weekly full-time wages of about 609,000 workers. Among those who received increases during the month were workers in the iron and steel industry, the increases being payable under sliding scale arrangements based on the index of retail prices.

In the first six months of this year, agreed changes in wage rates resulted in 4,959,000 workpeople receiving increases aggregating £1,971,900 In the industry group entitled "engineering, shipbuilding and electrical goods," it is stated that 409,000 workers received increases in their weekly full-time wages which aggregated £181,400. There were no decreases in wage rates reported during the first six months of this year. In the first half of last year, there was a net increase of £2,883,500 in the weekly full-time wages of 7,188,000 workpeople. At the end of June this year, the index of rates of wages (June 1947=100) stood at 129 for all workers, compared with 126 at the end of last year.

Unity in Industry

Once a year, Sir Charles Colston, chairman and managing director of Hoover, Ltd., addresses a meeting of shop stewards and employee representatives of his company. He takes the opportunity then to outline the company's progress in relation to the national economy and also to talk on subjects of current interest.

This year's meeting was held recently, and among other matters, Sir Charles made reference in his address to what he called the common interests of employers and workpeople. The livelihood of both employers and workpeople, he said, was wrapped up in the success of industry, and enduring success could only be achieved by maximum effort, a real team spirit and unity of purpose. That need for united effort, Sir Charles urged, extended to all those engaged in industry —directors, managers, the men in the factories, accountants and salesmen. It was no good, he continued, for the people in industry to look to the Government of the day to coddle them. If one industry was coddled or subsidised or protected, it was only at the expense of the rest. Industry must be strong enough to stand on its own legs. If all those engaged in industry worked together with a will, Sir Charles emphasised, they should be able to tackle with confidence whatever difficulties they had to face.

Trade Disputes

During June, there were 157 stoppages of work through industrial disputes reported to the Ministry of Labour. In addition, there were still in progress at the beginning of the month twenty-one stoppages which had started before June. The Ministry says that, in these 178 stoppages of work, 65,800 people were involved directly and indirectly during June, with an aggregate loss of 233,000 working days. Most of the stoppages occurred in the coal mining industry, in which 58,000 working days were lost by 27,600 workpeople. In the vehicle building industry there were ten stoppages, which involved 27,000 workers and caused an aggregate loss of 122,000 working days.

With its report on stoppages of work which occurred in June, the Ministry of Labour has published some statistics dealing with stoppages through disputes during the first six months of the present year. In that period, 904 stoppages were reported, the number of people involved in them being 217,400, and the aggregate number of working days lost being 931,000. The figures for the comparable period of last year were 906 stoppages, involving 238,500 workpeople, and causing a loss of 1,221,000 working days. The stoppages which occurred in the first half of this year included forty-five in the engineering industry. They affected 20,600 workpeople, and caused a loss of 164,000 working days.

Copper Prices

The Ministry of Materials has announced that it has now concluded negotiations with the principal Commonwealth suppliers on the price of copper from August 1st. The arrangements which have been made provide for a fixed price which will remain in force for a minimum period of six weeks from that date, and thereafter unless owing to changed circumstances any of the parties give notice of desire to re-negotiate. In view of these arrangements, the Ministry of Materials has been able to reduce its selling price of copper by £2 to £285 a ton, delivered consumers' works. Discounts and premiums remain unchanged.

The Coal Situation

On Wednesday of last week, there was a debate in the House of Lords on the National Coal Board's latest annual report. In the course of it, Lord Leathers, the Secretary of State for the Co-ordination of Transport, Fuel and Power, said that he would be very disappointed if coal production this year fell far short of 226,000,000 tons, which would include about 11,000,000 tons from opencast workings. He did not overlook the fact, however, that the increase in coal production in the past few years had been accompanied by an even greater increase in demand.

Dealing with mining manpower, Lord Leathers said that, whereas the number of miners usually rose during the first three months of the year and then declined during the next six months, this year the falling-off had not happened. There seemed to be a very good hope that the year would end with a mining labour force substantially greater than at the beginning of the year. One particularly good sign, Lord Leathers added, was the number of boys the industry had been recruiting, the total being over 14,000 in the first six months of this year, compared with 10,000 in the corresponding period of 1951. The Coal Board's target, he stated, was to secure within the next eighteen months or so a labour force 25,000 greater than in 1951.

Later in his speech, Lord Leathers said that a big difficulty hindering colliery development was the shortage of mining engineers with the necessary experience of planning major reconstruction schemes. It represented one aspect of the general problem of raising the standards of technical management in the industry. The production of more highly trained mining engineers, Lord Leathers observed, was inevitably a slow process, but the National Coal Board was going forward a great deal. It had provided a large number of technical scholarships to men from within and without the industry. Furthermore, three years ago, the Board introduced a scheme of directed practical training for potential colliery managers which had now been extended to include mechanical and electrical and other engineers. By the end of last year, 264 men were in training, and it was hoped eventually to take 200 trainees a year.

Steel Allocations

The first Lord of the Admiralty, Mr. J. P. L. Thomas, was asked in Parliament on Wednesday of last week what assurances he could give that the proportion of United States steel allocated for shipbuilding would be of the type and quality essential to that industry. In his reply, the First Lord said that none of the steel imported from the U.S.A. was specifically earmarked for shipbuilding. Within the limits of the tonnage of steel they were licensed to acquire, shipbuilders were free to procure supplies of the types and qualities they needed from any United Kingdom steel supplier. In answer to further questions, the First Lord stated that the steel allocation for merchant shipbuilding would be increased from October. The precise increase had not yet been settled, but it would not be less than 5 per cent.

On the same day, the President of the Board of Trade, Mr. Peter Thorneycroft, during the debate on the economic position, stated that the steel allocation to the exporting industries during the fourth quarter of this year was being "significantly and substantially increased." It was not possible, Mr. Thorneycroft said, to forecast precisely what would be the turnover in steel for the export industries in 1953. It could, however, be clearly stated that the more steel given to the exporting industries and the more capacity thus made available to them, the greater would be the amount of exports obtained. The Government's aim and object was to give the engineering exporters the opportunity they needed.

Heavy Electrical Plant Consultative Council

The Minister of Supply, Mr. Duncan Sandys, stated in Parliament last week that he had constituted a Heavy Electrical Plant Consultative Council, which would meet under his chairmanship. He said that its terms of reference were "to provide a means of regular consultation between the Government and the heavy electrical plant industry on matters affecting the well-being of the industry and its contribution to the national economy." This council, the Minister explained, would replace the Heavy Electrical Plant Committee, the meetings of which were discontinued in July, 1950. Those appointed to the new council are: Mr. E. H. Ball, Mr. I. R. Cox, Sir Claude Gibb, Sir George Nelson, Sir Harry Railing and Mr. B. H. Leeson (representing electrical plant manufacturers); Mr. C. K. F. Hague, Mr. F. G. Mitchell, Mr. F. G. Penny, Mr. E. W. Thompson, Mr. W. E. Young (representing water tube boiler manufacturers); Sir John Hacking, Mr. I. A. Park and Sir Henry Self (British Electricity Authority); and Mr. E. Foulkes and Mr. E. J. Hill (Confederation of Shipbuilding and Engineering Unions).

Notes and Memoranda

Rail and Road

THE SHOWMAN'S ENGINE.—In a recent letter to *The Times*, Mr. W. G. R. Weeks, of Newcastle upon Tyne, put forward a suggestion that a fairground traction engine should be acquired for the Science Museum. "These examples of robust British workmanship," he claimed, "were fast disappearing from our fairgrounds." A subsequent letter, from Mr. F. Sherwood Taylor, Director of the Science Museum, says that the Museum is negotiating for the acquisition of an 8 h.p. compound "Scenic" engine, built in 1924 by Charles Burrell and Sons, Ltd., Thetford. The Museum has also recently acquired, through the courtesy of the Road Locomotive Society, a 6 h.p. Aveling and Porter engine, built in 1872.

Air and Water

INSTITUTION OF NAVAL ARCHITECTS.—Her Majesty the Queen has been graciously pleased to grant her patronage to the Institution of Naval Architects, in continuation of that granted by King Edward VII, King George V and King George VI.

SAFETY OF LIFE AT SEA.—On July 2nd a notification of accession to the International Convention for the Safety of Life at Sea was received in London from the Government of Israel and the accession takes effect from October 2, 1952.

S.S. "ANTILLES."—The French Line announces that the S.S. "Antilles," which is nearing completion at l'Arsenal de Brest and is a sister ship to the "Flandre," will make her first sailing from Southampton to the West Indies on October 3, 1952.

THIRD SEA LORD.—The Queen has approved the appointment of Vice-Admiral R. A. B. Edwards, who is serving as Flag Officer, Second-in-Command, Mediterranean Station, to be a Lord Commissioner of the Admiralty, Third Sea Lord and Controller of the Navy in succession to Admiral Sir Michael M. Denny.

CARGO HANDLING.—The International Cargo Handling Co-ordination Association has extended its corporate membership to the Australian Ministry of National Development, the Auckland Harbour Board, the Italian Ministry of Merchant Marine, the German Federation of Shipowners, and the German Ports Association.

T.S.S. "CHUSAN."—The P. and O. liner "Chusan" has been fitted recently with a new funnel top, designed by John L. Thornycroft and Co., Ltd., to prevent smoke, fumes and soot descending upon the superstructures. By careful planning the whole operation was completed during the normal turnround period. During the first cruise observations were taken at regular intervals. At no time did the smoke touch the ship's structure and the condition of the paint reflected the improvement effected.

PETROL PORT OF LAVERA.—On July 17th the oil tanker "Helicina," of 18,100 tons deadweight, belonging to the Anglo-Saxon Petroleum Company, Ltd., was the first ship to dock at Mole 1 of Marseille-Lavera port's newly built quay and the occasion was marked by a short ceremony. The port which the Marseille Chamber of Commerce is constructing opposite Port-de-Boue will have five basins, 340m long by 120m wide, in which nine large tankers can be moved simultaneously. The second mole is expected to be ready for service by the end of September of this year.

R.N.V.R. ENGINEERING AND ELECTRICAL OFFICERS.—The Admiralty has announced that National Service R.N.V.R. engineering and electrical officers serving in the Royal Navy can now apply for permanent commissions in the Royal Navy under the "university candidate" scheme of entry. Applications can be made after completion of one year's service. Conditions of entry will be identical with those applying to university candidates who are not doing their National Service, except that certain time served as temporary officers will be counted for seniority purposes.

GATWICK AIRPORT.—A written reply by the Minister of Civil Aviation, Mr. Lennox-Boyd, says that it has now been decided to develop Gatwick as the southern alternative to London Airport and as a base for some scheduled services and other air transport activities. The detailed plans for the development of the airport are to be discussed with the local authorities in the near future. This decision, the reply explains, should be regarded as part of the development of airport facilities in the London area. It leaves unchanged the Government's decision to proceed with the development of Prestwick as the second international airport in the United Kingdom.

AIR TRAFFIC, JUNE, 1952.—Air transport movements recorded at United Kingdom aerodromes in June, 1952, totalled 20,368, 2·2 per cent less than in June, 1951. Passengers handled totalled 314,162, being an increase of 10·3 per cent on the number for June, 1951. Freight, on and off-loaded at 3911·6 short tons, showed a decrease of 15·2 per cent. At London Airport there were 3136 air transport movements (a decrease of 10·6 per cent from June, 1951), and passengers handled totalled 84,885 (an increase of 4·4 per cent). Northolt recorded 4318 transport movements, a decrease of 4·8 per cent, while passengers handled increased by 2·1 per cent to 82,750. Other airports at which passenger traffic increased considerably over June, 1951, were Isle of Man (Ronaldsway), 19,618 (17·4 per cent increase): Prestwick, 19,366 passengers (37·7 per cent increase): Manchester (Ringway), 17,876 (35·5 per cent increase). Jersey Airport handled 34,253 passengers, an increase of 43·8 per cent, and Guernsey, 14,434, an increase of 39·3 per cent.

NAME OF P. AND O. LINER.—The liner at present under construction by John Brown and Co., Ltd., for the Peninsular and Oriental Steam Navigation Company is generally similar to the "Himalaya" in power, size and speed, and will be given the name of "Arcadia." The first "Arcadia" was one of the "Jubilee" class of 1887–8, and was broken up during the first world war. The name has been made available to the P. and O. Line by William Watkins, Ltd., tug owners. This company had named a tug "Arcadia" after the old liner, and have now changed the name of this vessel to "Badia," so that the original name may be used for the new liner, which, it is hoped, will be launched next year.

SHIPYARD BROCHURE.—Under the title "Our Ships at Work," R. and W. Hawthorn, Leslie and Co., Ltd., has issued a brochure giving a pictorial review of some of the company's post-war products covering the years 1946 to 1952. This publication coincides with the centenary of the founding of the Hebburn Shipbuilding Yard by Andrew Leslie, although the engine works at St. Peters were started by Robert Hawthorn in 1817, and a brief record of the firm's one hundred years of shipbuilding is included in the brochure. The ships illustrated include oil tankers, refrigerated cargo ships, cargo liners, ore carriers, passenger liners, and naval vessels. The second part of the brochure is concerned with the shipyard and engine works, and a series of photographs, some of which are coloured, gives a pictorial record of the various stages in the building of a ship and illustrate the many types of engines constructed by the company. The centenary enclosure, "A Cavalcade of Ships Over the Century," includes profiles of nearly fifty merchant and naval vessels selected from those built since the founding of the business and a short account of the work of the founder, Andrew Leslie.

Miscellanea

ECONOMIC CONDITIONS IN PERU.—A survey of economic and commercial conditions in Peru has been published by H.M. Stationery Office, price 3s. 6d. It is the latest volume in the series of overseas economic surveys issued by the Commercial Relations and Exports Department of the Board of Trade.

INTERNATIONAL TIN RESEARCH INSTITUTE.—The International Tin Research and Development Council has resolved that it will in future be known as the International Tin Research Council. This change will not affect the policy of the council nor alter its current activities.

CENSUS OF PRODUCTION REPORTS.—In connection with the final report on the Census of Production, 1948, new reports, entitled *Mechanical Handling Equipment* (Volume 4, Trade G), and *Tool and Implement* (Volume 5, Trade A), have been published by H.M. Stationery Office. Their prices respectively are 3s. and 3s. 6d.

CRUDE OIL PRODUCTION.—During the first half of this year world crude oil production was 304,752,000 metric tons, which was just over 15½ million tons more than in the corresponding period of last year, and well over 6 millions more than in the second half of 1951. Middle East oil production has increased so that the loss of Persian oil has been made good.

SWEDISH SPONGE IRON PLANT.—A new sponge iron plant is to be built at Oxelosund, Central Sweden, by the Grangesberg-Oxelosund Company. An annual production of 30,000 tons is planned by the sponge iron method developed by the Swedish Hoganas Company. The plant is to be erected near to the Oxelosund pig iron works, and will utilise the coke and blast-furnace exhausts from those works.

GLASS FIBRE PLASTICS.—The Council of the British Plastics Federation has called an informal meeting at its offices at 47, Piccadilly, London, W.1, at 2.30 p.m. on August 14th, to discuss the machinery which might be set up within the federation to cater for firms interested in reinforced low-pressure glass-fibre plastics. Any non-member firms interested are asked to communicate with the director of the federation at the above address.

VACATION SCHOOL ON ELECTRICAL INSULATION.—A five-day Vacation School on the insulation of electrical equipment is to be held in the electrical engineering department of Imperial College of Science and Technology, London University, from Monday to Friday, September 15th to 19th. The object of the school is to consider the factors which are limiting insulation design in the main classes of electrical equipment and the general principles which should govern the approach to the solution of outstanding problems in this field.

BUSINESS EFFICIENCY EXHIBITION.—The Office Appliance and Business Equipment Trades Association announces that the next Business Efficiency Exhibition will be held at the Kelvin Hall, Glasgow, from November 4th to 14th. Commenting on the growth of overseas business, the Association says that in the first six months of this year office machinery exports from this country were valued at £5,137,816, a figure nearly £1,000,000 higher than that for the corresponding period of last year, and £1,200,000 greater than the value of similar exports in the whole of 1949.

B.B.C. SUMMER SCHOOL.—About forty professors and lecturers from twenty-one universities and technical colleges in Great Britain and Northern Ireland took part in a summer school at the British Broadcasting Corporation's Engineering Training Department, Wood Norton, near Evesham, from July 14th to 18th. The object was to give teachers in electrical engineering an opportunity to hear about the methods used in the B.B.C. for broadcasting sound and television and to take part in informal talks with B.B.C. engineers and the heads of some of the programme departments. Lectures were given by senior members of the engineering division of the B.B.C. on the work of the research and designs departments, and of the operations and maintenance departments. The training methods used in the engineering division were described by the head of the Engineering Training Department, Dr. K. R. Sturley, and a number of demonstrations were given in the laboratories. Visits were paid to the transmitting stations at Daventry and Sutton Coldfield. In addition to the technical lectures and visits, there were lectures on audience research, on the broadcasting of drama, and on feature programmes by the heads of the departments concerned. The summer school ended with an informal discussion under the chairmanship of the chief engineer, Mr. R. T. B. Wynn.

RENDERING OUTSIDE WALLS.—The Ministry of Works has prepared an "advisory leaflet," entitled *Rendering Outside Walls*, which gives guidance on precautions to be taken in choosing a rendering, on the mix to use and the method of application in order to avoid failure by cracking or separation from the background. There are notes on kinds of background and on the preparatory work needed, and the leaflet also gives practical hints on the suitability of various renderings for different purposes. A table is included showing the mix proportions to be used on "strong" and "weak" backgrounds in exposed and sheltered positions. Copies of the leaflet (No. 27) can be obtained from H.M. Stationery Office, price 3d. each.

PRESTRESSED CONCRETE THEORY AND DESIGN.—The Yorkshire Association of the Institution of Civil Engineers has stated that a course of twenty lectures on "Prestressed Concrete Theory and Design" is to be given at the University of Leeds, between October and March next. In addition to the lectures, there will be laboratory demonstrations on the behaviour of prestressed concrete beams. The lectures will be delivered on Tuesday evenings by Professor R. H. Evans, M.I.C.E., and Mr. E. W. Bennett, A.M.I.C.E. Attendance at the course is restricted to sixty engineers and the fee will be £3 3s. Application for attendance should be made to Miss M. Spink, assistant to the Director of Extra-Mural Studies, The University, Leeds, 2.

Personal and Business

MR. R. R. C. RANKIN, A.M.I.E.E., has been appointed technical manager in the equipment division of Mullard, Ltd.

MR. ALLAN C. COOPER has been appointed general manager of I.T.D., Ltd., 95–99, Ladbroke Grove, London, W.11.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., states that Mr. Ian Quigley, B.Sc., A.M.I.E.E., has been appointed sales manager (export), lamps and lighting.

RICHARD LLOYD, Ltd., Steelhouse Works, Birmingham, announces the opening of a new office in London at 240, Romford Road, Forest Gate, E.7 (telephone, Maryland 2564).

AUSTIN AND LANG (SALES), Ltd., Wembley, announces that it has appointed A. A. Jones and Shipman, Ltd., Narborough Road South, Leicester, as sole distributing agent for Great Britain and overseas for Lunzer rotating centres.

THE MINISTER OF TRANSPORT has nominated Major R. A. B. Smith, A.M.I.C.E., M.I.Struct.E., M.Inst.T., to be a member of the special panel of the Transport Tribunal in succession to the late Mr. E. S. Shrapnell-Smith, C.B.E.

MR. D. B. COLLETT, vice-president and general manager of the Dunlop Tire and Rubber Goods Company, Ltd., Toronto, is returning to this country to join the main board of the Dunlop Rubber Company, Ltd., as an executive director.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., states that Mr. L. de Wynter has been appointed manager of its Ipswich branch in succession to Mr. A. R. Driessen, who has been appointed commercial manager of the Indian Cable Company, Ltd.

THE ANGLO-SAXON PETROLEUM COMPANY, Ltd., announces that Captain William Shaw, the Commodore Master of the company's oil tanker fleet will retire at the end of August due to ill-health, and will be succeeded by Captain James Thornton, at present in command of the "Velletia."

MAJOR D. T. BROWN has been appointed agricultural engineering consultant and representative in India and Pakistan for Salopian Engineers, Ltd., Prees, Whitchurch, Salop; E. V. Twose, Ltd., Tiverton; John Wilder, Ltd., Wallingford, Berks, and Kenneth Hudson and Son, Darlaston.

BRYCE FUEL INJECTION, Ltd., and Berger Equipment, Ltd., have now amalgamated under the title of Bryce Berger, Ltd. The business will be conducted at Ironbarks Works, Staines, Middlesex. Mr. Miles Beevor is the chairman of the new company and Mr. S. Webster, managing director.

Contracts

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., has been awarded the £100,000 contract to supply the equipment for a television service in Venezuela, which will be operated by Television Venezolana S.A. at the capital, Caracas.

C. M. HILL AND CO. (ENGINEERS), Ltd., of 44/45, Tower Hill, London, E.C.3, has received an order on behalf of its principals, S. A. Familleureux, for fifty bogie steel covered goods wagons of 35 tons capacity, and twenty bogie cattle wagons, for the Benguela Railways.

British Patent Specifications

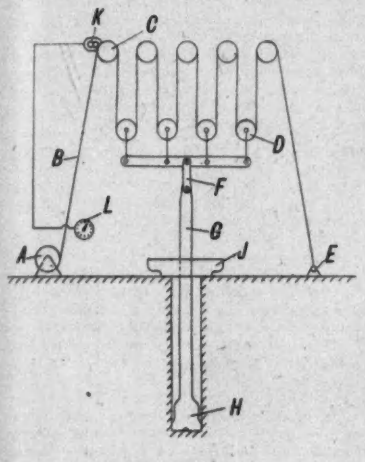
When an invention is communicated from abroad the name and address of the communicator are printed in Italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

MINING ENGINEERING

675,374. January 5, 1950.—ROTARY BORING PLANT FOR DEEP BORES, Haniel and Lueg, G.m.b.H., Dusseldorf-Grafenburg, Germany.

The drawing illustrates diagrammatically the whole arrangement of a rotary boring plant. *A* indicates the rope drum of the lifting gear. The pulley tackle rope *B* is led alternately over the upper rope pulleys *C* and under the rope pulleys *D* of the lower movable pulley tackle block and is anchored at a fixed point *E*. In the middle of the lower pulley tackle block the flushing head *F* and the boring rods *G*, together with the boring bit *H*, are suspended. Directly over the borehole is a rotary table *J*, by means of which the bore rods are rotated. On the tower head an electric transmitter *K* of a remote control tachometer is arranged in such a way that its driving disc is directly driven by the first rope pulley of the tackle. The



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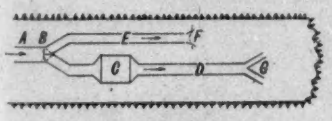
current produced in the transmitter *K* on the rotation of the pulley *C* actuates an indicator *L* arranged at the overseer's post. The indicator indicates the speed at any moment of the rope *B* passing from the rope drum *A* of the lifting gear to the first rope pulley of the tackle. Since the distance covered by a point of the first pulley-tackle rope pulley, which actuates the transmitter *K* is in direct relation to that of the paying-out rope *B* of the pulley tackle and therefore to the speed of sinking of the boring bit *H*, that speed is indicated according to the dimensions of the rope pulley gear or the speed of the ropes. The indicating arrangement may be so constructed that it acts on the regulating arrangement of the flushing pump and automatically adjusts the requisite minimum quantity of flush water according to the magnitude of the sinking speed, and also records the sinking speed and the quantity of flush water.—*July* 9, 1952.

675,736. January 31, 1951.—THE VENTILATION OF HOT WORK PLACES IN MINES OR TUNNEL WORKINGS, Ruhrstahl Aktiengesellschaft, Witten on the Ruhr, Germany.

The accompanying drawing illustrates diagrammatically apparatus for carrying out the invention. Atmospheric air is blown forward through a pipe *A* and is split up a little in front of the site in a branched pipe fitted with a regulating valve *B* so that one part of the ventilating current passes forwards over the cooler *C* of a refrigerator into a cold air pipe *D*,



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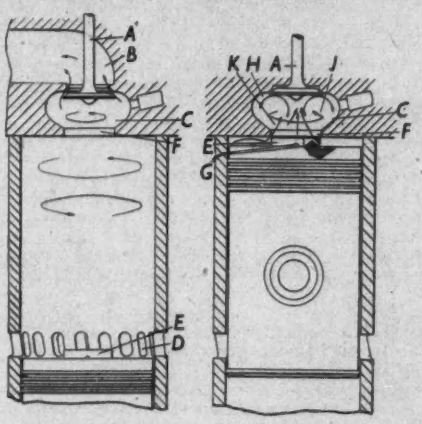
which conducts it to the work place. The other uncooled part of the ventilating current passes through a scavenging or cleansing air pipe *E*, the outlet end of which is disposed so far from the work place that it is in no danger from blasting operations. At the outlet end of the scavenging air pipe are air deflecting devices *F*. Air guide devices *G* at the outlet end of the cold air pipe *D* deflect the cooled air to the work places. During blasting the whole amount of the air can be passed forward through the cooler after the cleansing air current in the pipe has been cut off.—*July* 16, 1952.

INTERNAL COMBUSTION ENGINES

675,582. July 29, 1949.—TWO-STROKE INTERNAL COMBUSTION ENGINES, Nicolas Iturbe y Basabe, 43, Rosario, Cadiz, Spain.

The invention has for its object to improve the turbulence of the combustible charge so as to effect a more efficient combustion. As shown in the left-hand drawing, the exhaust valve *A* is open to permit discharge of burnt gases to an exhaust duct *B* from the cylinder by way of a combustion chamber *C* in which a fuel injector is situated. At its inner or lower dead centre, as shown, the piston uncovers an annular series of intake ports *D*, which are designed to impart a swirling motion to entering air which enhances the scavenging effect of the air in expelling the burnt gases from the cylinder, and also maintains



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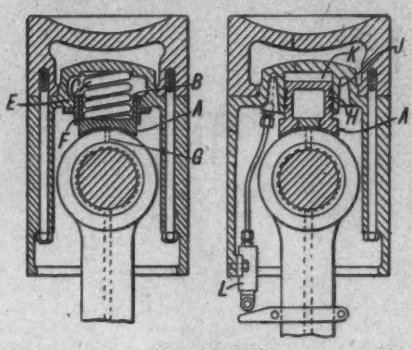
a swirling motion of the air after the closing of the exhaust valve and during compression. The projection *E* on the piston crown, which is coaxial with and adapted to enter an opening *F* from the combustion chamber to the cylinder, has its upper surface made concave to define a heart-shaped axial section for the combustion space. The exhaust valve is formed with a boss as shown to assist in defining the heart-shaped section. When in the course of the compression stroke the piston attains the position shown in the right-hand drawing, the passage area for air from the cylinder to the combustion chamber is sharply reduced on the entry of the projection on its crown into the opening. The projection, however, has a series of radial ducts *G* extending at an upward inclination, which continue to afford passage for air into the combustion chamber until the piston actually attains its outer dead centre. Air passing through these ducts creates a turbulence in the sense indicated by arrows *H*, which is superimposed on the rotatory turbulence above mentioned and indicated by arrow *J*, while a supplementary transfer of air through the gap between the lateral wall of the projection and the corresponding wall of the opening *F* imparts additional turbulence as indicated by arrow *K*.—*July* 16, 1952.

675,862. May 30, 1949.—GUDGEON PIN BEARINGS OF TRUNK PISTON ENGINES, Frederick William George, Henry Robert Green, Admiralty Engineering Laboratory, West Drayton, Middlesex; and Denys Chester Ford, K.C.B., C.B.E., Vice-Admiral (E), R.N., Engineer-in-Chief of the Fleet, The Admiralty, London, S.W.1.

The invention relates to the lubrication of the gudgeon pin bearings of trunk piston engines. The first view is a section of an assembly including a helical compression spring, and the second view a section including coacting hydraulic cylinder and piston parts. Referring to the drawings, the end of a connecting-rod has that portion of its outer surface towards the crown of an engine piston formed as a cylindrical bearing surface, concentric with the axis of the gudgeon pin. In contact with this surface is one end of a shoe *A*, shaped to bed accurately on the connecting-rod surface. The other end of the shoe consists of a shallow cup-shaped part *B*, open towards the crown and having inner and outer concentric and cylindrical surfaces coaxial with the axis of the piston. In part of the shoe is inserted one end of a helical compression spring *C*, the other end of the spring being located in a recess formed in a diaphragm which is part of the engine piston skirt. An inwardly directed circumferential flange *E* on the skirt close to the diaphragm carries a locating and guiding sleeve *F*. The part of the shoe in contact with the connecting-rod is faced with antifriction bearing metal, and lubrication of the working surfaces is provided by tapping the supply to the gudgeon pin bearing by a communicating passage *G* drilled through the connecting-rod small end. Referring to the second view, the end of the connecting-rod is similarly arranged and one end of the shoe *A* bedded to it. The other end of the shoe towards the crown is formed as a hydraulic piston *H* with sealing rings, and is located in a cylindrical part *J* of the skirt. The hydraulic piston and the cylinder



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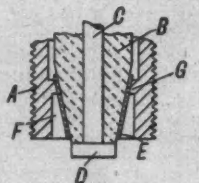
enclose between them a liquid-filled chamber *K* in communication through a pipe with a small pressurising device or hydraulic pump *L* which is operated by means of a cam attached to the connecting-rod. The pump can draw the requisite amount of liquid from the piston cooling medium where such is employed or from the lubricating oil supply to the gudgeon pin bearings by way of suitable ducts. Each piston is thus provided with a gudgeon pin bearing load-relieving device, which exerts a force sufficient to reverse the direction of the resultant load on the gudgeon pin bearing or bearings during some part of the engine cycle, so that adequate lubrication can be maintained.—*July* 16, 1952.

675,203. April 13, 1949.—SPARKING PLUGS, Joseph Lucas, Ltd., Great King Street, Birmingham, 19. (*Inventor: John Andrew Laird.*)

The invention relates to sparking plugs for internal combustion engines and has for its object to enable a gap of relatively low sparking voltage to be provided in a simple and convenient manner. Referring to the drawing, the hollow metal body part *A* is made of any convenient form, and within it is secured a ceramic or equivalent insulator *B*. Through an axial bore in the insulator a metal stem *C* extends, on the inner end of which is a head *D*, which serves as one of the electrodes. The inner end of the insulator is shaped to accommodate a metal sleeve *E*, which serves as the earthed electrode. The two electrodes *D* and *E* form between them a narrow circumferential spark gap, the base of which is



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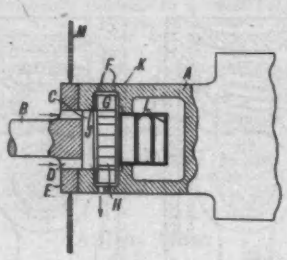
formed by the exposed portion of the insulator. The bore at the inner end of the body surrounding the sleeve is made of such diameter as will leave around the sleeve an annular gas pocket *F*, which is open at its underside. Connection between the sleeve and body is effected by a narrow flange *G* on the body at the inner end of the pocket. The sparking plug described is intended for use in ignition systems in which the spark is obtained from the discharge of a condenser, and in which the sparking voltage should be as low as can be conveniently obtained.—*July* 9, 1952.

GAS AND STEAM TURBINES

675,584. August 16, 1949.—HIGH-TEMPERATURE TURBINES, Gasturbine Maatschappij N.V., Surinamestraat, 4, 'S-Gravenhage, The Netherlands.

The invention provides an improved solution of the problem of keeping the bearing temperature within the limits permissible for the lubricant and makes the transfer of heat through the shaft as small as possible. The drawing shows a longitudinal section through the portion of a rotor for a steam or gas turbine with an adjacent supported butt shaft. The rotor *A*, which in operation attains a high temperature, is hollow, and at its free end is connected to the butt shaft *B*. The hollow space *C* in the hot rotor portion communicates with the surroundings by means of two series of apertures or passages

arranged at different radii, the apertures *D* of the first series being formed in the flange *E* of the butt shaft, whilst the second series is formed by staggered rows of apertures *F*, arranged in the thin wall portion *G* of the rotor portion. A row of vanes *H* within the hollow space is rigidly secured to the hollow rotor portion at *J*. The vanes also prevent the air passing through the hollow space from causing a whistling



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noise. The assembly so formed, upon rotation, operates as a centrifugal fan and draws in atmospheric air through the apertures *D* along the butt shaft and discharges it into the atmosphere through the apertures *F*. In order to protect the butt shaft, the end of the rotor, and the vanes *H* against heat radiation, radiation baffles *L* are arranged in an extension of the hollow space *C*. In conclusion, there is arranged around the free end of the rotor a shroud *M* having a bevelled edge and shielding the entrance zone of the cooling air from the zone of exit so as to prevent the formation of a circumferential flow of hot air and to render the cooling action as intensive as possible.—*July* 16, 1952.

STEAM GENERATORS

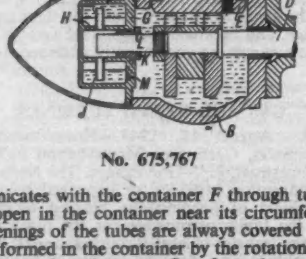
675,358. December 15, 1950.—SPREADER STOKERS, Babcock and Wilcox, Ltd., Babcock House Farringdon Street, London, E.C.4.

The invention relates to spreader stokers, during the operation of which the means for sprinkling the fuel is only protected from the heat radiating from the furnace, when throwing fuel. Should the fuel supply be stopped, as when shutting down, banking fires, or accidentally, the fuel sprinkling device is liable to damage through overheating. According to the invention, fitted between the spreader stoker housing and the firebrick wall of the furnace chamber there is a heat-resistant door, which can be raised or lowered by gear arranged above the nozzle plate of the stoker. The door has a lower edge parallel to the nozzle plate, so that when it is lowered the edge engages the nozzle plate, which is covered by the lower edge of the door. If the loosely inserted nozzle plate is removed the door can be lowered still further to seal the opening, and to shut off the whole housing from the furnace chamber, so that the spreader rotor can be removed for examination or overhaul without undesirable leakage of air into the furnace chamber.—*July* 9, 1952.

MARINE ENGINEERING

675,767. March 24, 1949.—MARINE PROPELLERS WITH VARIABLE-PITCH BLADES, Nils Johannes Liaaen, Alesund, Norway.

In the drawing *A* is the propeller shaft, *B* the hub, *C* a propeller blade, and *D* the operating rod, passed through a bore in the propeller shaft and rotating the propeller blades by means of a crank disc *E*. *F* is the compression and expansion container secured to a plate *G* covering the aft opening of the hub. The end of the operating rod is supported in the plate *G* and extended into a sleeve *H*. The sleeve



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communicates with the container *F* through tubes *J*, which open in the container near its circumference. The openings of the tubes are always covered by the oil ring formed in the container by the rotation of the propeller, so that air cannot flow from the container into the hub. In order also to safeguard against inflow of air to the hub when the operating rod is moved, but the propeller is not rotated, the oil filling must always be kept so large that its level, when the rod is in its foremost position, at least reaches the uppermost point of the hollow of a lining *K*, and at least two tubes must be used, so arranged that one or more reach down into the oil when the propeller is not rotated. In the lining *K* there are one or more grooves *L* for the communication of oil between the hub and the sleeve. The communication between the hub and the container may be by bores *M* in the plate *G*, with outlet to the hub, as shown with dotted lines. When the operating rod is pushed backwards the oil from the sleeve is pressed through the tubes to the container, thereby compressing the air. When the operating rod again is pulled forwards the air expands so that oil is pressed back through the tubes and the hub is always held completely filled with oil. With such a construction the oil pressure in the hub always remains higher than the pressure of the sea water and the closed container seals off the end of the rod completely. A modified design is also described in the specification.—*July* 16, 1952.

Books Received

Elements of Statistics. By C. G. Lambe. London : Longmans, Green and Co., Ltd., 6 and 7, Clifford Street, W.1. Price 8s. 6d.

Three-Phase Motors, Theory and Operation. By T. F. Wall. London : George Newnes, Ltd., Tower House, Southampton Street, W.C.2. Price 30s.

Locomotive and Train Working in the Latter Part of the Nineteenth Century. By E. L. Ahrons. Cambridge : W. Heffer and Sons, Ltd. Price 18s.

Marine Auxiliary Machinery. Edited by E. Molloy. London : George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Price 35s.

Railway Commercial Practice : Vol. I, *General and Passenger.* By H. F. Sanderson. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 25s.

Purpose and Practice of Motion Study. By Anne G. Shaw. London : Harlequin Press Company, Ltd., 20, Irving Street, Leicester Square, W.C.2. Price 50s.

Safety Rules for Use in Chemical Works : Part II, *Detailed Instructions.* London : The Association of British Chemical Manufacturers, 166, Piccadilly, W.1. Price 25s.

Chemical and Electro-Plated Finishes. By H. Silman. Second edition, revised. London : Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 50s.

Steel Defects and Their Detection. By Henry Thompson. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 15s.

Practical Metal Turning for Engineers. Fourth Edition. By J. G. Horner. London : The Technical Press, Ltd., Gloucester Road, Kingston Hill, Surrey. Price 20s.

Basic Mathematics of Technology. Vol. II. By J. Chance and G. F. Sims. London : University of London Press, Ltd., Warwick Square, London, E.C.4. Price 12s. 6d.

Welding of Non Ferrous Metals. Vol. III. Edited by E. Fuchs and H. Bradley. London : Butterworths Scientific Publications, Ltd., Bell Yard, Temple Bar, W.C.2. Price 22s. 6d.

Bibliographical Survey of Flow Through Orifices and Parallel-Throated Nozzles. By T. H. Redding. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 32s. 6d.

Coal Mines Act, 1911 : Regulations and Orders Relating to Safety and Health, 1951 edition. London : Her Majesty's Stationery Office, York House, Kingsway, W.C.2. Price 4s.

Airplane Design Manual. Third edition. By Frederick K. Teichmann. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 55s.

Engineering Machine Shop Practice. Third edition. By B. Richard Hilton. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 15s.

Building and Public Works Administration, Estimating and Costing. Fourth edition. By Spence Geddes. London : George Newnes, Ltd., Tower House, Southampton Street, W.C.2. Price 35s.

A Complete Guide to the Building (Safety, Health and Welfare) Regulations. London : The Royal Society for the Prevention of Accidents, Terminal House, 52, Grosvenor Gardens, S.W.1. Price 15s.

A Guide to the Principal Safety Requirements of the Factories Acts, 1937–1948. London : The Royal Society for the Prevention of Accidents, Terminal House, 52, Grosvenor Gardens, S.W.1. Price 15s.

Law Relating to Building and Engineering Contracts. By W. T. Creswell. Fifth edition. By T. R. D. Davies London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 30s.

Data Book for Civil Engineers : Vol. I, *Design ;* Vol. II, *Specifications and Costs.* Second edition. By E. E. Seelye. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price: Vol. I, 80s.; Vol. II, 104s.

Marine Steam Engines and Turbines. By W. J. Fox and S. C. McBirnie. London : George Newnes Ltd., Tower House, Southampton Street, Strand, W.C.2. Price 35s.

Modern Production Control. Second edition. By A. W. Willsmore. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 15s.

Codes of Practice

BITUMEN FELT ROOF COVERINGS

THE Council for Codes of Practice for Buildings has now issued in final form Code 144.101, "Bitumen Felt Roof Coverings." It was drawn up by a committee convened on behalf of the council by the Royal Institute of British Architects, and the present code is a revision of the draft previously issued for comment. The code deals with the laying of bitumen felt roofing on sloping and horizontal roofs constructed of timber, concrete and similar materials. It gives information on accessory materials used in conjunction with the felt roofing. Recommendations for the preparation of the base, the provision of associated details, the selection of the felt and number of layers required for various climatic conditions are included. Advice is given on the technique of fixing the felt roofing and on surface finishes. Diagrams illustrating the laying and arrangements for certain closely associated features such as gutters, drips and damp-proof courses are given. The code carries the usual warning that, in the present abnormal conditions, it may not be practicable to carry out all the recommendations. Copies may be obtained from the British Standards Institution, 24/28, Victoria Street, London, S.W.1, price 4s.

SANITARY APPLIANCES

THE Council for Codes of Practice for Buildings has now issued in final form Code 305, "Sanitary Appliances." It was drawn up by a committee convened on behalf of the Council by the Institution of Municipal Engineers, and is a revised version of the draft previously issued for comment. The code deals with the selection and installation of sanitary appliances. It does not, however, include the supply of water to such appliances or the disposal of water after use in the appliances. These two allied subjects are dealt with, respectively, in Code 310, "Water Supply," and Code 304, "Soil and Waste Pipes Above Ground." Comprehensive descriptions are given in the code of all commonly used appliances, distinction being made between those which are connected to the soil system and those connected to the waste system. A large section deals with such matters as grouping of appliances, ventilation of sanitary compartments, sound insulation and supports for appliances, together with specific recommendations as to the types, location and methods of installation of appliances in various kinds of buildings such as houses, flats, shops, schools, hospitals, offices, &c. A full list of relevant British Standards is included and there are notes on such practical aspects as storage, siting, fixing and maintenance of sanitary appliances. Copies of the Code may be obtained from the British Standards Institution, 24/28, Victoria Street, London, S.W.1, price 3s.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX

Fri. to Mon., Sept. 19th to 22nd.—The Hayes, Swanwick, Derbyshire, Conference on "Information Service : Theory and Practice."

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Wed. to Wed., Sept. 3rd to 10th.—Annual Meeting in Belfast.

ENGINEERS' GUILD

Thurs., Sept. 25th.—Caxton Hall, Caxton Street, Westminster, London, S.W.1, Annual General Meeting, 6 p.m.

INDUSTRIAL WELFARE SOCIETY

Thurs. to Sat., Sept. 4th to 13th.—Keble College, Oxford, Third Annual Conference for Apprentices, Theme : "The Approach to Industrial Responsibility."

INSTITUTE OF FUEL

Tues. and Wed., Oct. 28th and 29th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, Conference, "A Special Study of Ash and Clinker in Industry."

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Wed., Oct. 1st.—Royal Society of Arts, John Adam Street, London, W.C.2, Annual General Meeting, 6.30 p.m.

INSTITUTION OF MINING AND METALLURGY

Tues. to Thurs., Sept. 23rd to 25th.—Imperial College of Science and Technology, Prince Consort Road, South Kensington, London, S.W.7, Symposium on Mineral Dressing.

INTERNATIONAL MACHINE TOOL EXHIBITION

Wed. to Sat., Sept. 17th to Oct. 4th.—Olympia, London.